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GROWTH RATE OF THE DIAMONDBACK MOTH, *PLUTELLA XYLOSTELLA* (L.) ON CAULIFLOWER

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(*Received* 30 *October* 1992)

Growth rate studies of the diamondback moth which is an important pest of cabbage and cauliflower revealed that the species had the gross reproductive rate of 109.31 female eggs/female. The true intrinsic rate of increase (rm) was 0.155 females per day. The finite rate of increase was found to be 1.168, thus the species multiplied 1.168 times per day and would multiply 2.96 times every week.

(*Key words:* intrinsic rate of increase, finite rate of increase, gross reproductive rate, *Plutella xylostella*)

INTRODUCTION

The diamondback moth, *Plutella xylostella* (L.) is one of the important pests of cruciferous crops and is cosmopolitan in distribution. In the cold-dry areas of Himachal Pradesh, this pest has been reported to cause serious damage to cabbage seed crop (BHALLA & DUBEY, 1986) whereas in the mid-hill regions of the state, it causes damage to cabbage as well as cauliflower seed crop. Preliminary studies on the life history of this pest were reported from the state (BHALLA & DUBEY, 1986). In pursuance of studies on population dynamics, the present paper attempts to report the growth rate statistics of this species when reared on cauliflower.

MATERIALS AND METHODS

A mass culture of *P. xylostella* was maintained under laboratory conditions on cauliflower plants at room temperature ranging from 22 to 28°C. Twenty sets of glass chimneys (20 cm × 15 cm) with known number of male and female adults were kept with their tops covered with muslin cloth. In each chimney, a few cauliflower leaves were held in glass tube filled with water. Eggs laid on the leaves were counted and batches of 25 eggs were transferred on fresh leaves to Petri dish having moist filter paper at the base. The larvae that hatched were also held in Petridishes. Daily record of mortality in eggs, larval and pupal stages was maintained. Adults that emerged on a particular day were kept individually in glass chimneys along with cauliflower leaves for mating and egg laying. Fecundity of each female was noted daily till the death of the last female. A life table was constructed according to the method of BIRCH (1948) and ATWAL & BAINS (1974). Sex ratio of 1:108 (M:F) was used to determine the daily average of female eggs.

RESULTS AND DISCUSSION

The average duration of egg, larva and pupa was 4, 13 and 6 days, respectively which more or less confirmed the findings of BHALLA & DUBEY (1986) and CHELLIAH

& SRINIVASAN (1986). The survival from egg to adult emergence was 84 per cent. The oviposition began on 26th day. The maximum longevity of the reproductive female was 15 days. The first female mortality occurred on the 11th day and increased gradually thereafter (Table 1). Based on the observations recorded, various growth parameters were calculated. The gross reproductive rate (GRR) of the species was 109.31 female eggs per female. The species had higher GRR and differed considerably from the net reproductive rate (RO) due to mortality of parent females earlier than the maximum longevity of 18 days. The value of RO was 85.47 indicating thereby that the population of *P. xylosterlla* was able to multiply 85.47 times on cauliflower in the generation time (T) of 29.84 days. Shorter generation time

TABLE 1. Life - table (for females), age-specific fecundity for *P. xylostella* on cauliflower.

Pivotal age (days)	Survival of females at age x	Number of females/ female			Trial rm	
					0.14	0.16
x	lx	mx	lxmx	xlxmx	e^{7-rmx} lxmx	e^{7-rmx} lxmx
0–23		Immature stages				
23–25		Pre-oviposition period				
26	0.84	13.78	11.58	301.08	333.38	198.20
27	0.84	10.14	8.52	230.04	213.24	124.26
28	0.84	15.53	13.05	365.40	283.95	162.19
29	0.84	15.38	12.92	374.68	244.39	136.84
30	0.84	13.59	11.42	342.60	187.80	103.07
31	0.84	10.99	9.23	286.13	131.95	70.98
32	0.84	8.62	7.24	231.68	89.98	47.45
33	0.84	4.61	3.87	127.71	41.81	21.61
34	0.84	9.14	7.68	261.12	72.14	36.55
35	0.84	2.15	1.81	63.35	14.78	7.34
36	0.72	2.95	2.12	76.72	15.05	7.33
37	0.60	0.83	0.50	18.50	3.09	1.47
38	0.15	0.65	0.10	3.80	0.54	0.25
39	0.04	0.69	0.03	1.17	0.14	0.06
40	0.01	0.26	0.01	0.40	0.04	0.02
41	0					
Total		109.31	90.08	2684.38	1632.28	917.62

TABLE 2. Net reproduction rate, generation time, innate capacity for increase and finite rate of increase in number of *P. xylostella* on cauliflower.

Gross reproductive rate (GRR)	109.31 female eggs/female
Net reproductive rate (RO)	85.47 female eggs/female
Mean length of generation TC $\frac{\Sigma \text{lxmx}}{\text{Ro}}$	29.84 days
Innate capacity for increase in number $\text{rc} = \frac{\log \text{eRo}}{\text{TC}}$	0.149 females/day
Intrinsic rate of increase $\text{rm} = e^{7-\text{rm}}\text{lxmx}$ (at 1096.6)	0.155 females/day
Corrected generation time $\text{T} = \frac{\text{Log eRo}}{\text{rm}}$	28.69 days
Finite rate of increase in number antilog e^{rm}	1.168 females/day
Weekly multiplication of population $(e^{rm})^7$	2.96

(T) may be attributed to increased feeding at favourable environmental condition and reduction in the developmental time (TC). The species had a capacity for natural increase 0.149 females/day. The overall capacity of an organism to increase expressed in terms of the intrinsic rate of increase (rm) was determined graphically (Fig. 1) was found to be 0.155. The present estimates of 'rm' was considerably lower than 0.213 reported by LIU *et al.* (1985) at a constant temperature of 25°C when reared on kale. Besides host, faster rate of development as affected by fluctuating temperature (CLOUDSLEY - THOMPSON, 1953) could be the possible reason for lower 'rm' value as determined in the present findings. With a daily finite rate of increase (λ) of 1.168 females/day, the population would multiply 2.96 times every week.

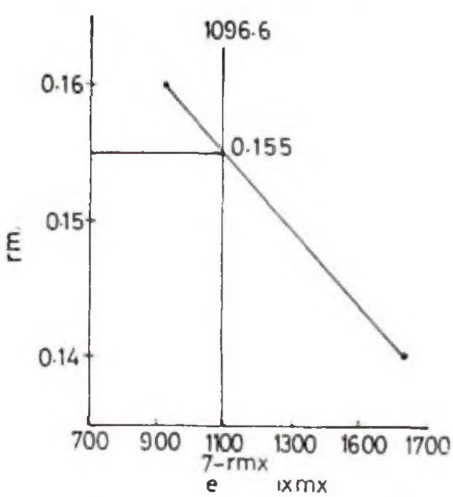

Fig. 1. Determination of true intrinsic rate of increase of *P. xylostella* on cauliflower.

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TAXONOMIC STUDIES ON *APHELINUS* (HYMENOPERA: APHELINIDAE). 7. A NEW SPECIES FROM NEPAL AND RECORDS OF THREE KNOWN SPECIES

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(*Received* 31 *March* 1993)

Aphelinus huberi **sp. nov. is described from a specimen collected in Nepal.** ***A. maculatus*** **Yasnosh and** ***A. marlatti*** **(Ashmead) are newly recorded respectively from Japan and Brazil. Male of** ***A. japonicus*** **Ashmead is described from a specimen collected in Japan, and a second specimen from Thailand is tentatively referred to this species.**

(*Key words:* Aphelinidae, *Aphelinus huberi*, sp. nov. from Nepal, three new records)

This is the seventh paper in a continuing series on the taxonomy of the aphelinid genus *Aphelinus* Dalman. It deals with material of four species received from the Biosystematics Research Centre, Canadian National Collections (= C.N.C.), Ottawa, through the kindness of Dr. J. Huber. Though each species is represented by a single specimen, these are considered here as the species either represent new records or show some morphological peculiarities.

All the material was returned to Dr. Huber

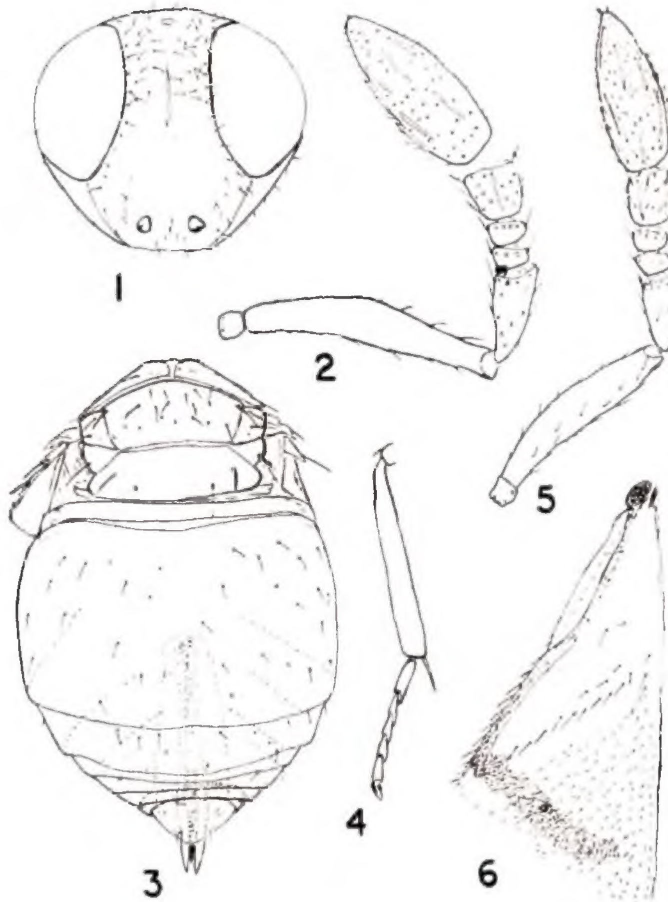
1. **Aphelinus huberi** sp. nov. (Figs. 1–4)

Female: Length, 0.76 mm. Head and thorax brown; gaster, except pale last tergum, dark brown; face yellow brown; antennae yellow brown with funicle yellow; coxae dark brown, femora and last tarsal segments brown, tibiae yellow brown, tarsal segments 1–4 yellow.

Body compact, depressed, suboval in outline; wings reduced. Head in front view as in Fig. 1; frontovertex, at narrowest, nearly 0.33 of head width and slightly longer than broad (12:10); frontovertex with minute setigerous punctures, each smaller than an ocellus; setae on head brown; occipital margin rather rounded, not sharp; eyes with pale setae, each seta shorter than diameter of an ommatidium; ocellar triangle with apical angle obtuse, each lateral ocellus slightly less than one ocellus diameter away from occipital margin and about two diameters of an ocellus from eye margin. Antenna as in Fig. 2.

Body as in Fig. 3, but the following may be noted: mid lobe of mesoscutum and scutellum finely reticulate, the cells hexagonal, these transversely drawn-out on anterior part of mid lobe; metanotum partly overlapped by scutellum; propodeum transverse, very slightly expanded on sides. Tergum I (= TI) of gaster large, about 1.66 × as long as rest of terga combined; TI and TII with irregular hexagonal reticulations, finer than on scutellum; setae on terga brown; ovipositor slightly longer than middle tibia (23:20); third valvula slightly less than 0.5 × of second valvifer (7:16) (Figs. 3, 4).

Male: Unknown.



Figs. 1–6. (1–4) *Aphelinus huberi*, sp. nov., holotype female: 1, head front view; 2, Antenna, clava from right antenna; 3, thorax and gaster, dorsal; 4, middle tibia and tarsus. Figs. 1, 3 and 4 on same scale. (5, 6) *Aphelinus maculatus* Yasnosh, female, Japanese specimen: 5, antenna: 6, part of fore wing.

Host: Unknown.

Distribution : Oriental : Nepal (known so far only from the type locality).

Holotype female (Ap. 160): NEPAL: Parbat Distr., Ghorapani Pass N. Slope. 2700m., 6.x.1983, Smetana & Löbl (C.N.C.)

Comments. This species was initially mistaken for a species of *Hirtaphelinus* Hayat (1983), with which it resembles in its habits and especially the large TI of gaster. However, it undoubtedly belongs in *Aphelinus*. *Hirtaphelinus* has an apparently undivided pronotum, two setae on each axilla, rudiment of fore wing subtriangular, setose and sclerotized, and gaster densely setose.

A. huberi, sp. nov. is the third species of the genus characterized by the extremely short wings, absence of a triangular median projection on posterior margin of propodeum (as in Fig. 11), and a large TI of gaster. The other two species, *A. marlatti* (Ashmead) and *A. mariscusae* (Risbec),

differ mainly by a shorter TI of gaster (not more than 0.4×of length of gaster) and in a more elongate body. Type of *marlatti* were seen by me, and a redescripton of *mariscusae* was published by Polaszek & Hayat (1990).

This species is named in honour of Dr. John Huber.

2. **Aphelinus maculatus** Yasnosh (Figs. 5, 6)

Aphelinus maculatus Yasnosh, 1979: 164. Female, male. Russia, Southern Primorya.

The specimen listed below agrees fairly well with the original description of *A. maculatus* and is here regarded as conspecific with that species. Some details are given here based on the Japanese specimen.

Female: Body including legs, yellow, paler ventrad; antennae white to pale yellow; tips of mandibles pale reddish brown; wings hyaline, fore wing with a reddish brown band as in Fig. 6. Setae on head, eyes and gaster pale, on dorsum of thorax brown; setae proximad of linea calva of fore wing and those on the infuscated band dark brown, other discal setae pale brown with dark bases. Mid lobe of mesoscutum (about 46 setae) and scutellum with line hexagonal cells, those on sides of scutellum longitudinally dawn out. Gastral terga I–VII with 5–6+5–6, 2+2, 2+2, 2 + 2 + 2, 2 + 2, 4 (between spiracles), and 8 setae respectively. Relative measurements (on same scale) of some structures are as follows:

Fore wing: length, width, length of venation, length of costal cell, length of marginal vein – 97, 41.5, 55, 30, 25.

Hind wing: length, width, fringe length, length of venation - 82, 19, 5, 52. Thorax length, 42; gaster length, 70; ovipositor length, 44; third valvula length, 14; middle tibia length, 32.5.

Material examined: 1 female (Ap. 157): JAPAN: Kibune, Kyoto, 6. viii. 1980, C. M. Yoshimoto (C.N.C.)

Host: Unknown for the Japanese specimen. Types reared from indet. Aphididae, but Yasnosh (1979) states that it is probably a Japanese species, *Hyalomyzus malisuctus* Mots., which reaches to the Southern Primorya.

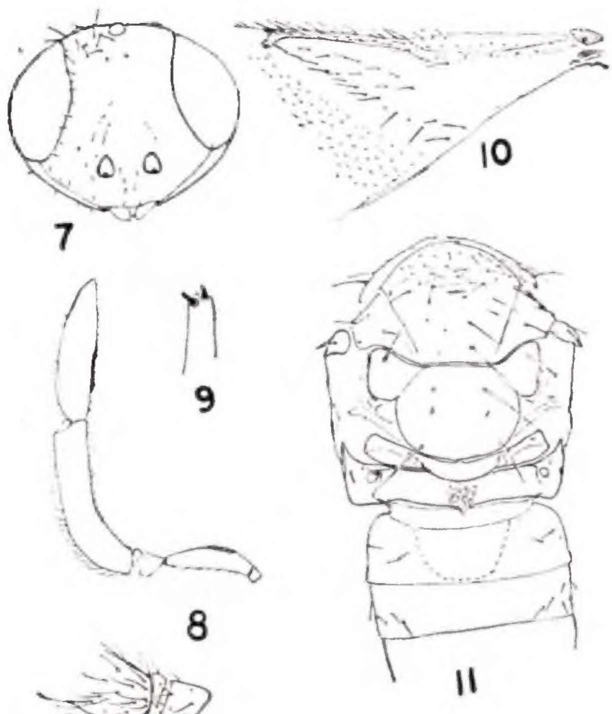
Distribution: Palaearctic : Russia, Japan.

3. **Aphelinus japonicus** Ashmead (Figs. 7–11)

Aphelinus japonicus Ashmead, 1904: 161. Female. Japan, Atami. Hayat, 1991: 179 Redescription.

This species was hitherto known in the female, and was recently redescribed by Hayat (1991). A male specimen collected in Japan and believed to be the male of this species is recorded and described here. The male is rather unique for the genus in having a 3-segmented flagellum of which F1 is anelliform, and the other two segments are long and setose, reminding me of the males (of apparently undescribed species) of some Neotropical *Centrodora* Foerster I had seen in the collections of the Natural History Museum, London. All other species of *Aphelinus* have 4-segmented flagella in both males and females.

Male: Head dorsum orange yellow, face and malar space yellow; occiput pale orange; collar of pronotum and mid lobe of mesoscutum brown; axillae, metanotum, scutellum and propodeum mesad of spiracles dark brown to nearly black; side lobes yellow to yellow brown; propodeum distad of spiracles brown; petiole, TI, and TII medially, yellow to slightly yellow brown; TIII (except brown medially), TIV, TV and TVI dark brown; TVII brown. Antennae yellow with setae pale brown. Wings



Figs. 7-11. *Aphelinus japonicus* Ashmead, male: 7, head front view; 8, left antenna, with pedicel, F1 and base of F2 enlarged; 9, digitus; 10, part of fore wing; 11, thorax and part of gaster.

hyaline, veins pale brown, setae dark brown Legs except apex of middle tibia which is brown.

Morphological details as in Figs. 7-11, but the following may be noted: setae on frontovertex pale brown, on face and malar space pallid; setae on thoracic dorsum dark brown; eyes densely setose, setae pale and fine, each seta at least as long as diameter of an ommatidium. Fore wing length: width 50:23; length of gaster: length of thorax, 63:51; length of phallobase: length of middle tibia, 23:35.

Material examined: 1 male (Ap. 162): JAPAN: Mt. Tachibanayama, Fukuoka, 12.viii.1980, C. M. Yoshimoto (C.N.C.).

Host: Unknown.

Distribution: Palaearctic: Japan.

Comments: I also assign to this species, with some hesitation, a male from Thailand (Doi Inthanon Nat. PK., 1260 m. 70 km S. Chiang Mai, 31.i.—7.ii.1989, T. W. Thormin. (C.N.C). This is very similar to the Japanese specimen, but differs mainly as follows: frontovertex relatively broader; fore wing with a single line of setae proximad of linea calva; each digitus with three denticles; mid lobe, except brown anterior third and axillae yellow, slightly differently coloured gaster; and last tarsal segment of middle and hind tarsi brown. This specimen may represent yet another species related to *A. japonicus*, but a definite opinion is deferred till further specimens including females could be collected.

4. **Aphelinus marlatti** (Ashmead)

Baeocharis marlatti Ashmead, 1988: v. Female, male. U.S.A., Kansas, Riley Co.

Aphelinus marlatti (Ashmead) : Gahan, 1924: 12. Synonymy.

This brachypterous species was known previously from the U. S. A. and Canada. A single female collected in Brazil apparently is a new record from that country. No further comments on this species are given here as these will be included in a paper by Hayat, Woolley and Schauff on the North American *Aphelinus*.

Material examined: 1 female (Ap. 158:) BRAZIL: Pocos de Caldas, Minas Cirais, vii.1972, O. Roppa & E. C. Becker, (C.N.C).

Host: Unknown for the Brazilian specimen.

Distribution: Nearctic : U.S.A., Canada; Neotropical: Brazil.

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I thank Drs. J. HUBER and G. A. P. GIBSON (B.R.C. Ottawa) for their help during my short visit to the B.R.C., and the former for arranging loan of much interesting material. I also thank Prof. Man Mohan Agarwal, Chairman, Department of Zoology, for providing facilities. Thanks are due to the Department of Science & Technology, New Delhi, for financial assistance through a Project on Indian Aphelinidae.

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SOME GENETIC PARAMETERS IN MULTIVOLTINE SILKWORM *BOMBYX MORI* L.

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(*Received* 29 *February* 1992)

Heritability, genotypic and phenotypic correlations of some important economic traits of multivoltine silkworm, *Bombyx mori* L. were studied by using standard statistical method.

(*Key words*: silkworm, heritability, genotypic correlation, phenotypic correlation)

The genetic parameters viz., heritability, genotypic and phenotypic correlations play a vital role in the formulation of breeding plans on scientific lines for the improvement of economically important plants and animals. The main use of genetic parameter estimates is in the prediction of selection response (Sheridan, 1988). In silkworm, heritability, genotypic and phenotypic correlations of some important economic traits were studied earlier (Petkov, 1981; Siddiqui *et al.*, 1985, 1988; Ozdzenska & Kremky, 1987). Recently Sarkar *et al.* (1991) studied broad and narrow sense heritability for cocoon weight in four inbred lines and their possible crosses. The present experiment was undertaken to estimate broad sense heritability, genotypic and phenotypic correlations among male and female populations of silkworm separately.

Five multivoltine inbred lines viz., 'Nistari' 'Raj' 'B' 'CB-5' and 'G' were reared in mass beds obtained from composite layings during April – May and June-July seasons. The heritability, genotypic (rg) and phenotypic (rp) correlations were estimated for some important economic traits viz., single cocoon weight (SCW), single shell weight (SSW), single pupal weight (SPW), cocoon shell ratio (SR %) and fecundity (in case of female). Data on important characters were recorded for 100 individuals of each sex in every breed in each season. Genotypic and phenotypic variance components were estimated from analysis of co-variance in one way classification having two factors viz., season and breed. Genetic and phenotypic correlations (rg and rp) and heritability (Broad sense) were calculated as per standard statistical techniques (Mather & Jinks, 1971).

Heritability (Broad sense) of multivoltine breeds for the important economic traits are presented in Table 1 for males and females separately. The heritability of all the traits in males was higher in all breeds when compared to females in both seasons. The maximum heritability was found for the traits SCW (63.65 %) and SSW (60.30 %) followed by SPW (62.36 %) and SCW (59.56 %) in males during June-July and April-May seasons respectively. In female population the highest heritability was recorded for SCW (58.22 % and 47.90 %) followed by SPW (57.57 %) and SSW (46.25 %) during June-July and April-May, respectively. Heritability of fecundity was very low in females. In case of heritability, similar results have been described by Sen *et al.* (1976) and Siddiqui *et al.* (1985).

TABLE 1. Heritability estimates of cocoon parameters of silkworm breeds.

Race	Season	SCW		SSW		SPW		SR %		Fecundity
		Male	Female	Male	Female	Male	Female	Male	Female	Female
Multi-voltine	April–May	0.5956	0.4790	0.6030	0.4625	0.5626	0.4477	0.3169	0.1356	0.1838
	June–July	0.6365	0.5822	0.5642	0.4844	0.6236	0.5757	0.2150	0.1796	0.1402

SCW: Single Cocoon Weight, SSW. Single Shell Weight, SPW: Single Pupal Weight. SR %: Cocoon Shell Ratio.

TABLE 2. Estimates of phenotypic and genotypic correlation in multivoltine silkworm.

PHENOTYPIC CORRELATION

Season	Sex	SCW Vs				SSW Vs			SPW Vs		SR % Vs
		SSW	SPW	SR %	Fecundity	SPW	SR %	Fecundity	SR %	Fecundity	Fecundity
April–May	Male	0.8417**	0.9925**	0.2290*	—	0.7695**	0.7132**	—	0.1095	—	—
	Female	0.8114**	0.9937**	0.1799	0.3871**	0.7416**	0.7153**	0.3697**	0.0708	0.3742**	0.1526
June–July	Male	0.8695**	0.9945**	0.2181*	—	0.8129**	0.6673**	—	0.1156	—	—
	Female	0.8389**	0.9962**	0.0754	0.4683**	0.7883**	0.6005**	0.5116**	0.0108	0.4476**	0.2494*

GENOTYPIC CORRELATION

Season	Sex	SCW Vs SSW	SCW Vs SPW	SCW Vs SR %	SCW Vs Fecundity	SSW Vs SPW	SSW Vs SR %	SSW Vs Fecundity	SPW Vs SR %	SPW Vs Fecundity	SR % Vs Fecundity
April–May	Male	0.9409**	0.9968**	0.6061**	—	0.9110**	0.8394**	—	0.5412**	—	—
	Female	0.9751**	0.9991**	0.7917**	0.4512**	0.9648**	0.9059**	0.6174**	0.7651**	0.4165**	0.8066**
June–July	Male	0.9556**	0.9982**	0.4685**	—	0.9363**	0.7082**	—	0.4150**	—	—
	Female	0.9404**	0.9987**	0.2322*	0.7858**	0.9223**	0.5476**	0.9281**	0.1835	0.7571**	0.7209**

* Significant at 1 %; ** Significant at 5 %.
SCW : Single Cocoon Weight; SSW : Single Shell Weight; SPW : Singal Pupal Weight; SR % : Cocoon Shell Ratio.

Highly significant genotypic and phenotypic correlations were observed between SCW and SPW between male and female populations (Table 2). The significant genotypic and phenotypic correlations were also found between SSW and SPW in males and females during both seasons. The genotypic correlation was significantly high between SSW and fecundity and for phenotypic correlation between SCW and fecundity, and SSW and fecundity during April-May and June-July, respectively. However, negative phenotypic correlation was found between SPW and SR% (-1.08%) during April–May. The genotypic and phenotypic correlation was extensively studied by SEN *et al.* (1976), SIDDIQUI *et al.* (1988) and NARASIMHARAJU *et al.* (1990) and reported most of the correlation values were low in magnitude except the value between cocoon and shell weight, which is positive and highly significant (SEN *et al.*, 1976). From the analysis of data, it is suggested that in order to improve the economic traits like single cocoon weight and cocoon shell ratio, emphasis should be given to single shell weight. Positive correlation also existed between single shell weight and fecundity. So, for selection strategy the indirect selection criteria may be adopted to improve single shell weight, single cocoon weight, cocoon shell ratio and egg laying capacity through single shell weight.

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Entomon 1994 Vol. 19 No. 3 & 4 pp. 95 to 99

THREE NEW SPECIES OF ERIOPHYIDS FROM TAMIL NADU (ERIOPHYIDAE: ACARI)

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(*Received* 30 *September* 1991)

The paper presents the description and figures of three species of eriophyid mites which are new to science. They are, *Aceria poae* sp. nov., *Calacarus palmae* sp. nov., and *Tetra coimbatorensis* sp. nov.

(*Key words:* Acari, Eriophyidae, *Aceria, Calacarus, Tetra*)

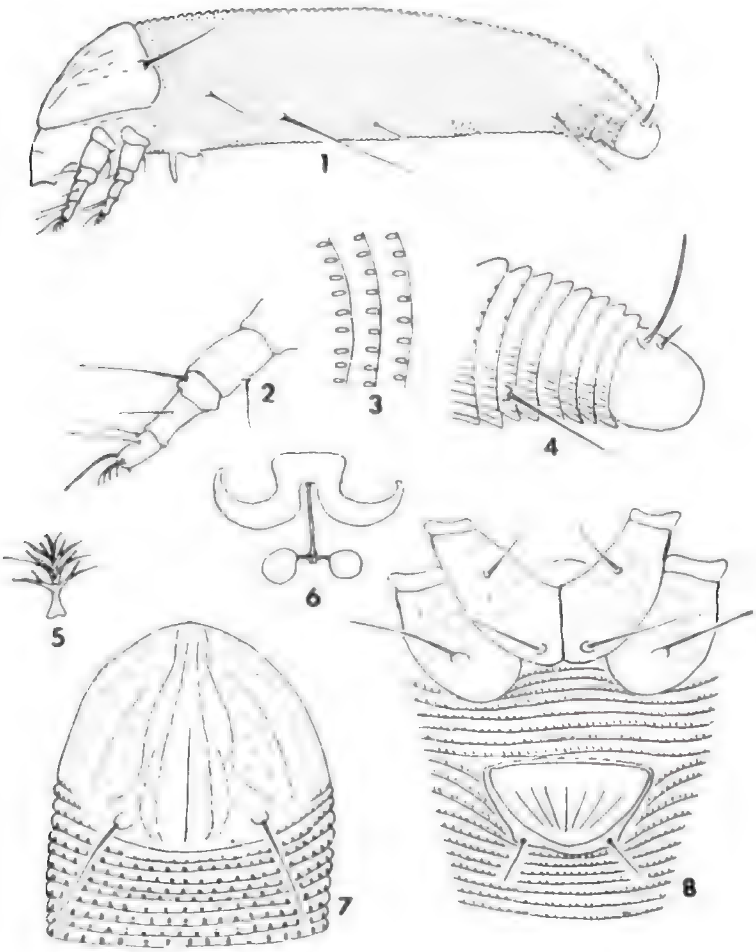
In the course of collection and study of phytophagous mites from Tamil Nadu, three species new to science were encountered. These are adequately described, sketched and presented below. The types and paratypes slides have been deposited in the Acarology collections of the Department of Agricultural Entomology, Tamil Nadu G. D. Naidu Agricultural University, Coimbatore 641 003, India. All measurements given in the descriptions are in μm.

Aceria poae sp. Nov. (Figs. 1–8).

Female: White, worm like, 200–210 long, 45 wide, rostrum 20 long, evenly down curved, antapical seta 5 long, shield triangular, blunt at front, 32 long, 35 wide, shield area with lines; median represented in the basal half, admedians represented by broken lines, first submedians represented in the basal half of the sheild as strokes, second submedians starts near the base of the dorsal tubercles, converge forward towards the first submedian and runs nearly parallel to the anterior end; third submedian near the shield border; area between third and second submedians with short scorings; sides of shield with dots and scorings; dorsal tubercles 16 apart; dorsal setae 35 long, pointing backward and outward. Foreleg 28 long, tibia 6 long, tibial seta at basal 2/3, 4 long; tarsus 5 long; claw 9 long, curved and tapering; featherclaw 4 rayed simple; hind leg 25 long, tibia 5 long, tarsus 5 long; claw 9 long similar to foreclaw; coxae with all three setiferous tubercles, tubercles II and III in line, tubercle I placed well in anterior position; coxal area with sparse, faint scorings. Abdomen with about 65 rings, uniformly microtuberculated, microtubercle, oval, large, sparsely placed, telosomal tergites devoid of microtubercles; lateral seta 25 long on ring 12; first ventral seta 40 long on ring 22, second ventral seta 10 long on ring 36; third ventral seta 25 long on ring 6 from behind; caudal seta 40 long, accessory seta very thin 1 long; female genitalia 23 wide, 12 long; coverflap with 7 lines, genital seta very thin 5 long.

Male: Not known

Type: Holotype ♀ marked on slide with several ♀♀, INDIA : Tamil Nadu : Coimbatore; 24.viii.1989, ex, *Agrostis tenuis* (Poaceae), M. Mohanasundaram Coll. (No. 564) TNAU.

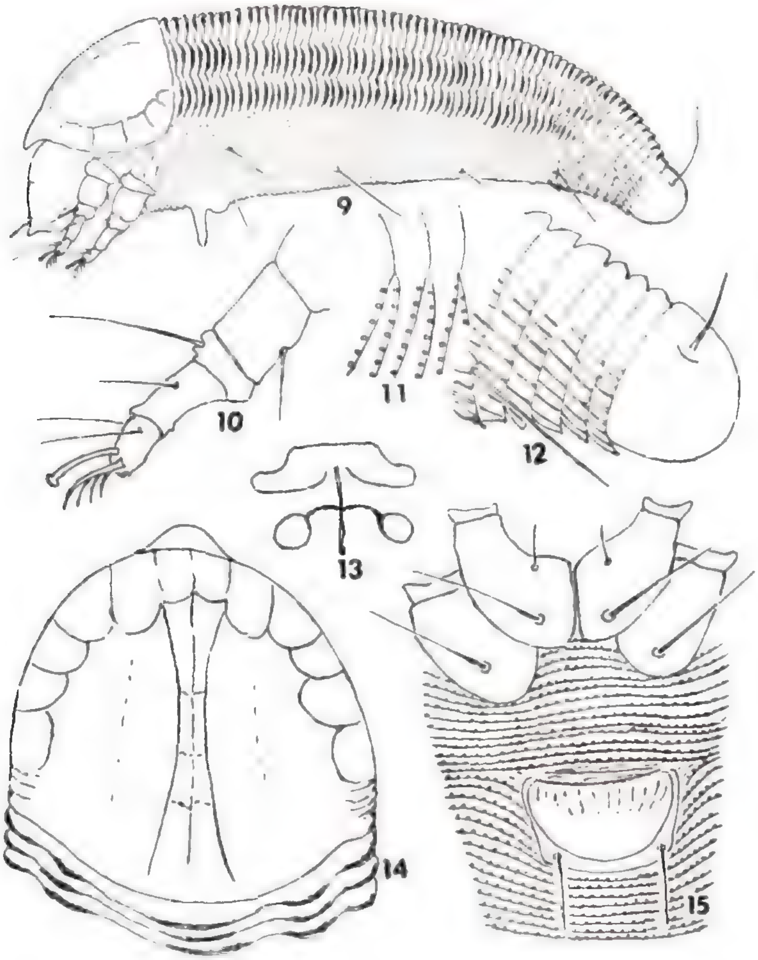


Figs. 1 to 8. *Aceria poae* sp. nov. 1. Side view of mite; 2. Left foreleg; 3. Side skin structure; 4. Side view of caudal end; 5. Feather claw; 6. Internal apodeme; 7. Dorsal view of anterior end; 8. Ventral view of coxae and genitalia.

Remarks: This species resembles *Aceria corchorae* Mohanasundaram (1987) in its shield pattern and 4 rayed feather claw, but differentiated from it by its coxal area with scorings, lesser number of lines on the female genital coverflap; and shape of the foreleg claw apart from the measurements. It is also differentiated from other *Aceria* spp. described from grasses by its characteristic shield pattern, claw, feather claw and measurements. It resembles *Aceria tulipae* (Keifer) (1938) in its shield pattern but differentiated from it by the four rayed feather claw.

Calacarus palmae sp. nov. (Figs. 9–15).

Female: 200 long, 60 wide, rostrum 20 long, down curved, antapical rostral seta 8 long, shield 40 long, 50 wide, with a pattern of cells along the anterior border. Median faint, represented by broken lines



Figs. 9 to 15. *Calacarus palmae* sp. nov. 9. Side view of mite; 10. Left foreleg; 11. Side skin structure; 12. Side view of caudal end; 13. Internal apodeme; 14. Dorsal view of anterior end; 15. Ventral view of coxae and genitalia.

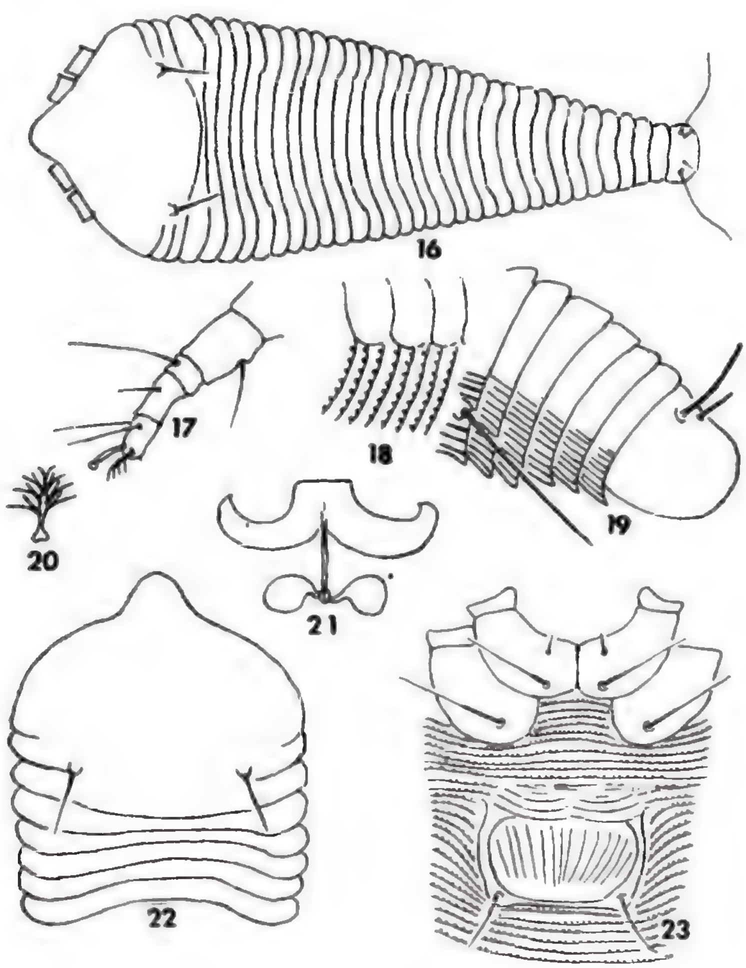
admedians complete with cross lines connecting with the median; submedian very faintly represented by broken lines; sides of shield with five cells on each side, dorsal shield tubercles and setae absent. Foreleg, 25 long, tibia 6 long, tibial seta 5 long at middle; tarsus 5 long, claw 5 long knobbed at tip; feather claw with 4 rays; hindleg 22 long, tibia 5 long, tarsus 5 long, claw 5 long, curved and knobbed at tip; legs with all usual setation; coxae broad with all three setiferous tubercles, coxal area smooth. Abdomen with about 65 smooth tergites and about 85 microtuberculate sternites. Dorsum with five wax bearing lines with a pair of dorsal and a pair of subdorsal troughs. Lateral seta 15 long on about ring 15; first ventral seta 20 long on about ring 35, second ventral seta 10 long on about ring 55, telosomal seta 15 long on ring

10 from behind; caudal seta 18 long; accessory seta absent. Female genitalia 25 wide, 15 long, coverflap with 10–12 faint lines in the basal region, genital seta 10 long.

Male: 180 long, 55 wide, genitalia 18 wide, genital seta 6 long.

Types: Holotype ♀ on slide, marked, INDIA : TAMIL NADU : Coimbatore, 24.viii.1989 ex ornamental potted palm *Collinia* sp (Palmae) M. Mohanasundaram, Coll. (No. 565); paratypes 5 slides with ♂♂ and ♀♀, collection data same as type.

Relation to host: The mites are found as under surface leaf vagrants; the mites light pink in colour while alive with 5 white wax bearing lines on its dorsum; a large number of white nymphal cast skins seen on the leaf surface; the feeding of the mites cause slight rusting symptoms on the lower side.



Figs.16 to 23. *Tetra coimbatorensis* sp. nov. 16. Dorsal view of mite; 17. Left foreleg; 18. Side skin structure; 19. Side view of caudal end; 20. Feather claw; 21. Internal apodeme; 22. Dorsal view of anterior end; 23. Ventral view of coxae and genitalia.

Diagnosis: The present species resembles *Calacarus alocasiae* Keifer (1978) by its four rayed feather claw but differentiated from it by the shield pattern. It is also different from other known species by the marginal cells in the anterior portion of the shield; the nearly complete median and admedian and by the absence of cells in the middle portion of the shield.

Tetra coimbatorensis sp. nov. (Figs. 16-23)

Female: Dirty white, dorsoventrally flattened, wedge shaped 160–170 long, 55 wide; rostrum 20 long, evenly down curved, antapical seta 5 long. Shield broadly triangular with a prominant lobe overhanging rostrum, 40 long, 50 wide; shield area and sides of shield smooth; dorsal tubercles near rear shield margin, 26 apart; dorsal setae 6 long. Foreleg 25 long, tibia 6 long tibial seta at about middle, 5 long; tarsus 5 long; claw 4 long knobbed at tip; feather claw 4 rayed; hindleg 23 long, tibia 5 long, tarsus 5 long, claw 4 long; legs with all usual setation. Coxae broadly joined, with all three setiferous tubercles; coxal area smooth. Abdomen with a broad dorsal trough fading towards the rear; with about 28–30 smooth broad tergites and about 65 narrow, finely microtuberculate sternites, microtubercles dot like. Lateral seta 20 long on ring 10, first ventral seta 25 long on ring 28, second ventral seta 7 long on ring 42, third ventral seta 15 long on ring 6 from behind, caudal seta 25 long; accessory seta thin 3 long. Female genitalia 20 wide, 15 long; coverflap with 12–14 lines; genital seta 10 long.

Male: Not known

Types: Holotype ♀ marked on slide, India : Tamil Nadu ; coimbatore; 16.viii.1989, ex *Grewia* sp. (Tiliacea) M. Mohanasundaram. Coll (N 566). Paratypes six slides with ♀♀, collection data same as type.

Remarks: The mites are found on the lower side of the leaves, causing very slight rusting symptoms. This species resembles. *Tetra anisomelae* Mohanasundaram (1984) in its clear shield area, smooth coxal area, and the 4 rayed feather claw but could be differentiated from it by the absence of any lines on the shield; the female genital coverflap with scorings and the presence of accessory seta apart from the measurements.

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A NEW GENUS AND TWO NEW SPECIES OF ERIOPHYID MITES (ERIOPHYIDAE: ACARI) FROM ANDAMANS

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(*Received* 20 *July* 1991)

A new genus *Hornophyes* and two new species *Hornophyes andamanensis* sp. nov; and *Artacris terminaliphagus* sp. nov. collected on *Terminalia* sp. from Andamans have been described.

(*Key words: Hornophyes, Artacris, Termialia*)

While screening plant materials collected from Andaman Islands, two new eriophyid mites were encountered of which one belonged to a new genus. The mites have been adequately sketched and described. The type and paratype slides have been deposited in the Acarology collections of the Department of Agiicultural Entomology, Agricultural College and Research Institute, Coimbatore 641 003, India. In the descriptions all measurements are given in μm.

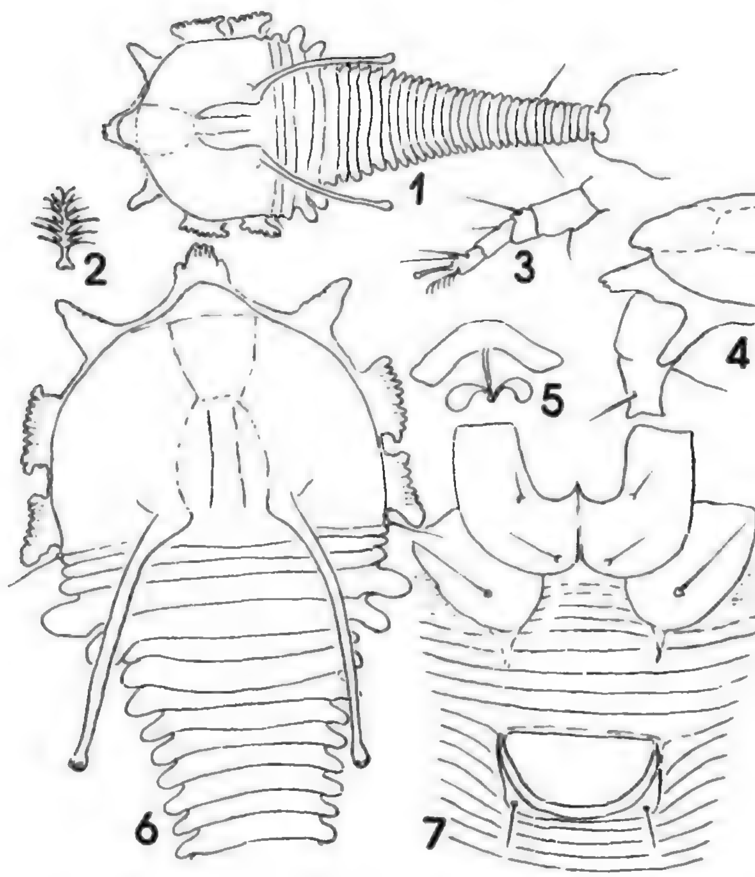
Hornophyes gen. nov.

Body broader anteriorly, tapering posteriorly, with broad tergites, shield with a median and two anterolaterally directed lobes below the shield margin; sides of shield margin with two pairs of corrugated projections; shield tubercles near rear shield margin, elongated, nearly as long as shield, projecting upward and backward, tubercles slightly tapering and blunt and bulging at tip without any dorsal setae. The tergites with lateral lobes, 5th and 6th tergite lobes quite big; legs with usual segmentation and setation; tergites and sternites devoid of microtuberculation in the type species; coxae with all three setiferous tubercles; abdomen with ventral seta I and II absent, other setae present, accessory seta absènt. Type species: *Hornophyes andamanensis* sp. nov.

This new genus is unique in its shield and the shield tubercles. The shield has anterior and lateral projections which are not known in any other genus. Also, this is the second genus which has the long dorsal tubercles, the first one being *Neocecidophyes* Mohanasundaram (1980) from which the present genus could be differentiated by the absence of the dorsal shield setae at the tip of the elongated tubercles. It is also differentiated from the above genus by its shield design; wedge shaped body with broad anterior end; absence of ventral seta I and II; and the position of the female genitalia away from the coxal base. The genus name is given based on the horn like disposition of the shield tubercles projecting upward and backward and quite prominently seen while alive during its movements. The new genus is referable under Phyllocoptinae in the family Eriophyidae (Boczek et al., 1989).

1. **Hornophyes andamanensis** gen. et sp. nov. (Figs. 1–7).

Female: Dirty white to light brown, dorsoventally flattened, broad at anterior end and tapering posteriorly; 140–150 long, 55–60 wide at the shield region; rostrum



Figs. 1–7. *Hornophyes andamanensis* gen et sp. nov. 1. Dorsal view; 2. Feather claw; 2. Foreleg; 4. Side view of anterior end of shield; 5. Internal apodeme; 6. Dorsal view of antrior half of the mite; 7. Ventral view of coxae and female genitalia.

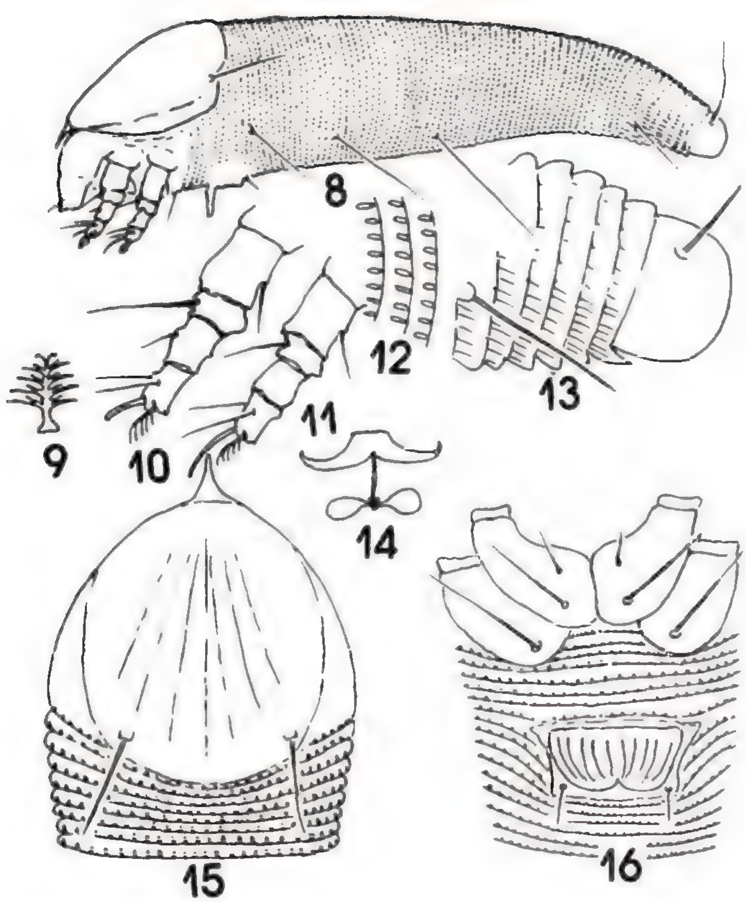
16 long, vertically down curved, antapical seta 9 long; anteriorly the dorsal shield lobe overhangs the rostrum base, completely covering the rostrum in dorsal view. Dorsal shield 60 wide, 50 long; dorsal tubercles just away from rear shield margin 14 apart 40 long, slightly tapering from base and bulging at the tip without any dorsal seta. Shield with median absent, admedians represented at the posterior half; submedians arising as folds in the base of the dorsal tubercles ascending to meet fiont margin connected at 0.5; sides of shield with two pairs of characteristic corrugated projecting lobes; anteriorly, there is a median corrugated lobe just below the anterior shield lobe, flanked on either side by a pair of blunt lobes connected to the median lobe. Foreleg 24 long; tibia 4 long, tibial seta 4 long; tarsus 4 long; claw 4 long straight and blunt at tip; feather claw simple 6 rayed; hindleg 22 long, tibia 3 long, tarsus 4 long; claw 4 long. Legs with all usual setation. Coxae with all three setiferous tubercles, coxal setae I and II small, while III is long; coxal area smooth.

Abdomen with about 32–35 tergites and about 40–50 sternites; the tergites and sternites are smooth devoid of any microtuberculation, except the area just below the shield where there are dot like microtubercles. Lateral seta just below the tergite one, about 8 long, first and second ventral setae absent; third ventral seta on ring 6 from behind, 12 long; caudal seta 18 long, accessory seta absent. Female genitalia just away from coxal base, 16 wide, 8 long, coverflap smooth; genital seta thin, 5 long.

Male: 130–140 long, 50 wide at shield, genitalia 10 wide, genital seta 7 long.

Types: A holotype slide with ♀ marked, along with several ♀♀ and ♂♂ ; INDIA : ANDAMANS : Port Blair, 25.v.1991 ex *Terminalia* sp. (Combretaceae), Coll; G. Shyam Prasad; 14 paratype slides with ♀♀ and ♂♂, collection data same as type (No. 581 TNAU)

Remarks: The species is an under surface leaf vagrant, slow moving and found



Figs. 8–16. *Artacris terminaliphagus* sp. nov. 8. Side view of mite; 9. Feather claw; 10. Foreleg; 11. Hindleg; 12. Side skin structure; 13. Side view of caudal end; 14. Internal apodeme; 15. Dorsal view of shield; 16. Ventral view of coxae and female genitalia.

in all arts of the leaf lower surface without causing any visible symptoms.

2. **Artacris terminaliphagus** sp. nov. (Figs. 8–16)

Female: White, worm like, 135–140 long, 35 thick; rostrum 15 long, down curved, antapical seta 4 long, shield 25 long, 30 wide, with a narrow lobe over the rostrum base, 5 long. Dorsal tubercles at shield margin, 20 apart, dorsal seta 10 long, pointing upwaid and backward. Shield area with thin, faint, lines representing median, admedians and submedians; sides of the shield fairly smooth. Foreleg 22 long, tibia 5 long, tibial seta at middle, 3 long, tarsus 5 long, claw 4 long, slightly bent and tapering; hindleg 20 long; tibia 4 long, tarsus 4 long; claw 7 long feather claws simple, 5 rayed. Coxae with all three setiferous tubercles, coxal area smooth. Abdomen with about 85–90 microtuberculate rings, without dorsoventral differentiation lateral seta 14 long on about ring 12; first ventral seta 18 long on about ring 30; second ventral seta 25 long on about ring 50; third ventral seta 10 long on ring 6 from behind; caudal seta 25 long, accessory seta absent. Female genitalia 18 wide, 10 long; coverflap with about 10 lines; genital seta 5 long.

Male : Not known.

Types: A holotype ♀ marked on slide, along with several ♀♀.

INDIA : ANDAMANS : Port Blair; 25.v.1991 ex *Terminalia* sp. (Combretaceae); G. Shyam Prasad Coll; nine paratype slides with ♀♀ collection data same as type (No. 582 TNAU).

Remarks: The mites cause extensive erineum patches on both sides of the leaf. The erinea are white with thickly packed club shaped hairs in the initial stages, later turning to brown. The white mites are seen in between the erineal hairs.

Affinities: The present species resembles *Artacris hirsutivagrans* Mohanasundaram (1984) in its 5 rayed feather claw but differentiated from it by the thin dorsal shield lines, clear coxal area, more number of lines on the genital cover flap and longer second ventral seta. It is also differentiated from *Artacris vadalurensis* Mohanasundaram (1983) by the non-granular shield sides, smooth coxal area, 5 rayed feather claw and the longer second ventral seta.

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HETEROBELTIOTIC ANALYSIS FOR SIX QUANTITATIVE TRAITS IN SOME SILKWORM (*BOMBYX MORI* L.) GENOTYPES

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6 × 6 diallel crosses of silkworm genotypes were analysed for magnitude of heterosis in 6 economic traits. Two combinations namely B 38 × C 108 and J 122 × B 38 exhibited superiority in being heterotic for 4 of the 6 traits. Combining ability analysis revealed significant effects due to general as well as specific combining ability for all the 6 characters thereby suggesting both additive and non-additive gene actions. Variance due to specific combining ability was, however, higher in magnitude than variance due to general combining ability indicating stronger influence of non additive genes.

(*Key words* : heterobeltiosis, quantitative traits, *Bombyx mori*, genotypes, combining ability, additive genes, non-additive genes)

INTRODUCTION

The concept of heterosis, in addition to its application in the field for high profitability has led to the selection of desirable parents/combiners for their utilization in future breeding programmes. Accordingly some of the existing bivoltine silkworm genotypes available at the Division of Sericulture, Mirgund, were analysed for heterobeltiosis and subjected to combining ability tests to assess the nature and magnitude of gene action involved in expressing various economic characters so as to frame the future breeding plan for further genetic improvement.

MATERIALS AND METHODS

Six existing bivoltine silkworm genotypes namely 'B 38', 'C 108'. 'C 122,' 'Jam 21,' 'J 122' and 'Sanish' were subjected to combining ability tests by crossing these in all possible directions. Thirty F1 combinations thus obtained were reared along with their parental breeds twice during, 1989–1990 at the Division of Sericulture, Mirgund. The experiment was laid out in a randomised block design with 3 replications for each treatment. The data of 2 rearings was pooled and analysed for heterobeltiosis. Only those crosses were considered to be heterotic where mean values exceeded that of its better parent significantly at 5% level in the desired direction. All other crosses were taken to be devoid of any heterosis (SATENAHALLI et al., 1989).

Heterobeltiosis was calculated by the following formula :–

$$\text{Heterobeltiosis} = \frac{\text{F1 -BP}}{\text{BP}} \times 100$$

In order to understand the nature and magnitude of gene actions involved in expressing various quantitative traits, combining ability tests were performed by applying GRIFFINGS (1956) method 1 and model 2 (SINGH et al., 1979).

TABLE 1. Heterobeltiosis per cent as shown by some crosses.

Cross		Wt. of 10 mature larvae	Single cocoon weight	Single shell weight	SR %	Yield /10,000 larvae By no.	By weight
B 38	× C 108	18.26*	16.95*	30.76*	—	—	18.84*
	× C 122	—	—	31.92*	28.04*	—	—
	× Jam 21	—	16.60*	19.35*	—	—	37.79*
	× J 122	—	17.73*	21.69*	—	—	21.56*
	× Sanish	—	—	—	—	—	27.28*
C 108	× B 38	—	15.00*	29.59*	—	—	24.15*
	× C 122	12.98*	—	—	—	—	—
	× Jam 21	—	16.02*	—	—	—	25.62*
	× J 122	18.48*	22.00*	—	—	—	—
	× Sanish	—	—	—	—	—	13.29*
C 122	× Jam 21	12.66*	—	—	—	—	14.07*
Jam 21	× B 38	—	12.31*	—	—	—	30.42*
	× C 108	—	—	—	—	—	32.17*
	× C 122	—	—	18.09*	15.18*	—	—
	× J 122	—	15.63*	20.42*	—	—	—
	× Sanish	—	9.43*	22.11*	—	—	18.59*
J 122	× B 38	22.10*	26.28*	40.99*	—	—	29.94*
	× C 108	23.23*	24.14*	38.58*	—	—	
	× Jam 21	—	16.41*	23.65*	—	—	19.33*
	× Sanish	—	—	17.91*	—	—	21.05*
Sanish	× B 38	—	—	31.59*	30.40*	—	—
	× C 122	—	—	21.07*	—	—	14.57*
	× Jam 21	—	9.96*	18.95*	—	—	14.59*
	× J 122	—	—	—	—	—	18.97*
CD		4.55	1.67	5.39	2.71	—	2.064

* Significant @ 5% level.

CD Critical difference at 5% level.

RESULTS AND DISCUSSIONS

Weight of ten mature larvae

Out of 30 F1 combinations only 6 have exhibited heterosis for this character, maximum being in 'J 122' × 'C 108' (23.23%) followed by 'J 122' × 'B 38' (22.10%), 'C 108'×'J 122', (18.48%), 'B 38' × 'C 108' (18.26%), 'C 108' × 'C 122' (12.98%) and 'C 122' × 'Jam 21' (12.66%).

Single cocoon weight

The highest heterotic effect for single cocoon weight was recorded in 'J 122' × 'B 38' (38.58%) and lowest in 'Jam 21' × 'Sanish' (9.43%).

Single shell weight

15 crosses have exhibited heterosis for this trait, 'J 122' × 'B 38' ranks supereme with a value of 40.99%.

SR %

Only 4 combinations have shown significant heterosis for SR% the maximum being in 'Sanish' × 'B 38' (30.40%) followed by 'B 38' × 'C 122,' 'B 38' × 'Sanish' and 'Jam 21' × 'C 122' with values of 28.04%, 27.28% and 15.18% respectively.

Yield per 10,000 *larvae* (by weight and by number).

16 combinations have registered heterosis for yield /10,000 larvae (by weight) ranging from 13.29% ('C 108'×'Sanish)' to 37.79% ('B 38' × 'Jam 21'). However, none of the crosses recorded any heterosis for yield/10,000 larvae (by number).

Amongst 30 F1 combinations only 24 have exhibited significant heterobeltiosis (at 5% level) for one or more characters (Table 1). 'J 122'×'B 38' and 'B 38' × 'C 108' reigns supreme in being heterotic for 4 of the 6 characters studied followed by 'B 38' × 'Jam 21,' 'B 38' × 'J 122', 'C 108' × 'B 38', 'C 108' × 'Jam 21', 'Jam 21,' × Sanish', 'J 122' × 'C 108', 'J 122'× 'Jam 21' and 'Sanish' × 'Jam 21' each showing heterosis for 3 traits.

TABLE. 2. Anova of combining ability for some quantitative traits in 6×6 diallel crosses of silkworm.

Source	DF	Wt. of 10 mature larvae	Single cocoon weight	Single shell weight	SR%	Yield/10,000 larvae	
						By no.	By weight
General combining ability	5	26.96*	349.02*	17.006*	1.790*	2385.4*	3.35*
Specific combining ability	15	10.16*	280.162*	539.238*	2.599*	3944.3*	4.28*
Reciprocal effects	15	12.29*	108.194*	12.123*	2.098*	3087.0	2.44*
Error	70	1.80	36.522	3.793	0.955	144.05	0.554
Var (gca)		1.42	6.39	NE	0.063	NE	NE
Var (sca)		4.85	141.46	310 90	0.955	145.38	2.160

* Significant at 5% level.

NE Negative estimates.

Combining ability analysis revealed significant GCA and SCA effects for all the 6 traits (Table 2) thereby suggesting both additive and non-additive genes play significant role in bringing the heterotic effects. However, SCA variance was higher in magnitude than GCA variance for all the characters (Table 2) indicating preponderance of non additive genes for these traits.

ACKNOWLEDGEMENTS

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A NEW SPECIES OF *XENASTER* MAHUNKA (1970) (TARSONEMINAE: ACARI) ON COCONUT FROM SOUTH INDIA

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A new species of tarsonemine mite, *Xenaster longiabdominalis*, sp. nov., collected from fallen coconut buttons has been described with the biological observations on the feeding behaviour and reproduction.

(*Key words*: *Xenaster*, Tarsoneminae, Acari, coconut)

In the course of collection and study of various groups of mites from South India, a new species of Tarsoneminae mite was collected from fallen coconut buttons collected from Vellayani region of Kerala. These were reared and multiplied on fallen coconut buttons under laboratory conditions and observations made on their feeding behaviour, development and reproduction. The species has been adequately described with figures and photographs. The types and paratype slides have been deposited in the Department of Agricultural Entomology collection, Tamil Nadu Agricultural University, Coimbattore 641 003, India. All measurements given in the description are in μm, unless otherwise stated.

Xenaster longiabdominalis, sp. nov. (Fig. 1 to 13)

Female: Length of non-gravid female 220 long and 80 wide. The idiosoma of the young female, flattened, elongate oval and dirty white in colour.

Dorsum:

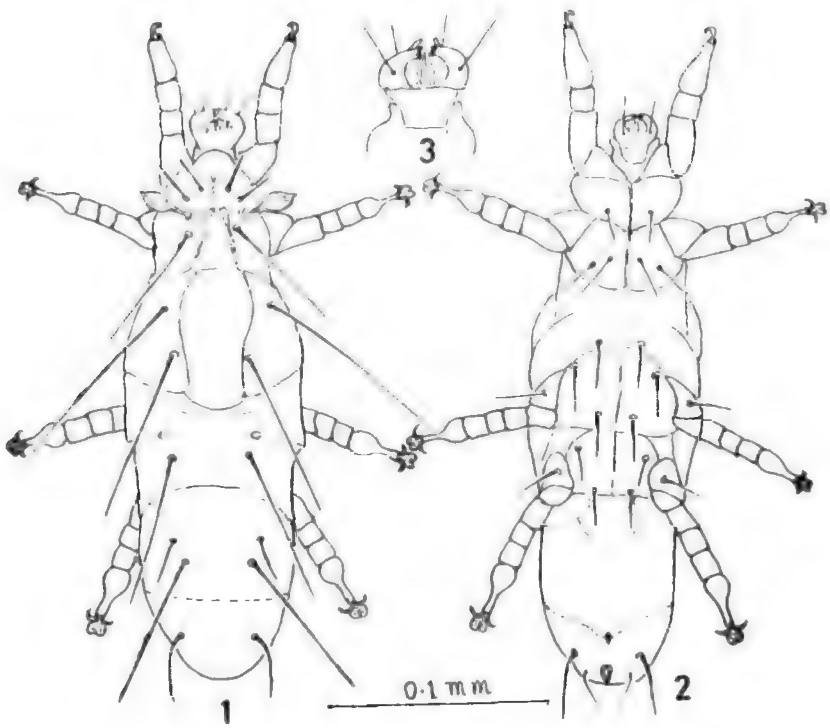
The propodosoma 40 long; nearly rectangular, pseudostigmatic organs have oval heads, 10 long, joined to thin stalks and are inserted into cup shaped structures. The hysterosoma 160 long with a slight bulge in the anterior and posterior lateral margins, and the anal opening at the posterior end situated ventrally. On the dorsal side the propodosoma bears three pairs of setae, DP I 30 long; DP II, 20 long; both situated in the anterior half and pointing sidewards; DP III 60 long, situated just behind the pseudostigmatic organ, pointing backwards. Hysterosoma with six pairs of setae, DH I, 50 long; DH II, 50 log; DH III, 55 long; DH IV, 16 long; DH V, 60 long and DH VI, 36 long. All hysterosomal dorsal setae rough and pointing backwards.

Ventrum:

Ventrally the propodosoma bears 3 pairs of short, smooth setae and the hysterosoma with 5 pairs of short, smooth setae in the middle and two pairs of setae at the posterior end on either side of the anal opening.

Gnathosoma:

The gnathosoma, 18 long trepezoidal with a broad anterior with two pairs of



Figs. 1–13. *Xenaster longiabdominalis*, sp. nov. 1. Dorsal view of female; 2. Ventral view of female; 3. Gnathosoma of female;

setae dorsally and one pair of setae on the ventral side.

Legs and their setation:

Leg I with 4 segments, i. e., fused coxa and trochanter, femur, genu and tibiotarsus ending in a thick hook like single claw; setation being, 0, 2, 2, 10 (2) (one solinidion dagger shaped and the other club shaped).

Leg II with the usual six segments, ending in a slender pretarsus with paired claw and a bilobed pulvillus; the setation being 0, 0, 3, 1, 4, 5.

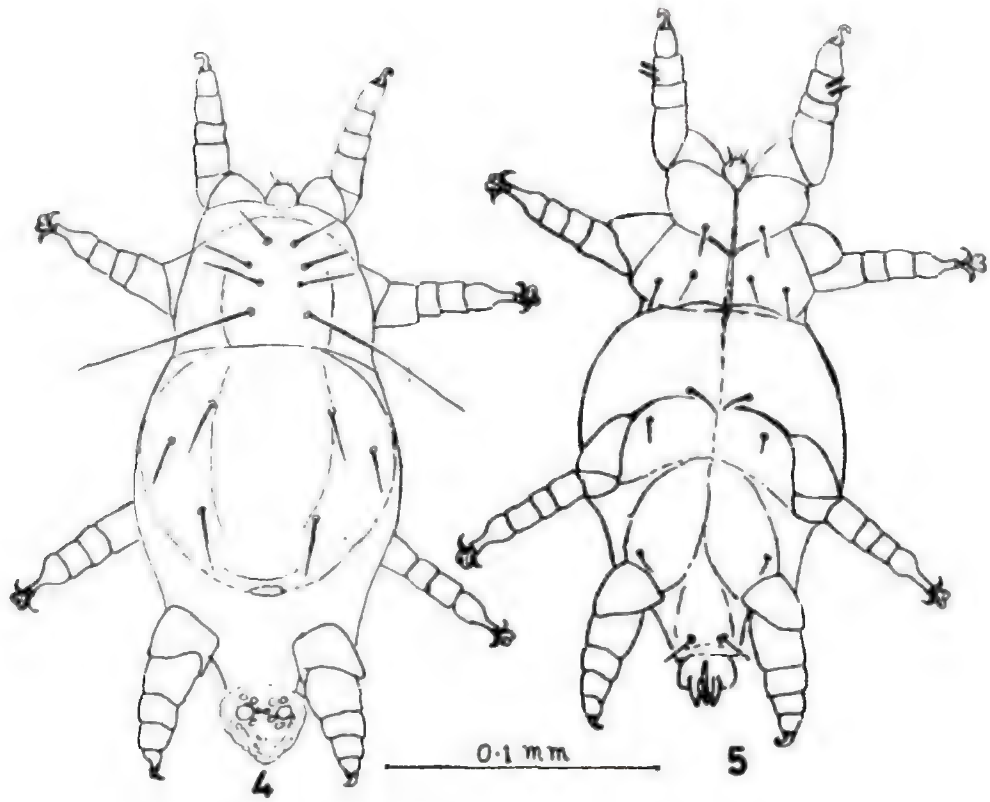
Leg III with six segments ending in slender pretarsus with a paired claw and bilobed pulvillus, the setation being 1, 0, 2, 1, 4, 4.

Leg IV with segments with slender pretarsus ending in a paired claw and bilobed pulvillus, the setation being 1, 0, 2, 1, 4, 4.

Male: Males are found among the non-gravid females as well as on the gravid females which are completely mature and ready to give birth to the juvenile mites. Dirty white, 200 long and 100 wide at middle

Gnathosoma:

Pear shaped, 8 long with two pairs of setae in the anterior end; all other parts atrophied; seems that males do not feed in their adult life.



Figs. 4–5. 4. Dorsal view of male: 5. Ventral view of male:

Dorsum:

With a nearly round shield in the hysterosomal region; propodosoma, with 3 pairs of short and one pair of long setae, hysterosoma with 3 pairs of long setae on the shield; and the abdomen ending conically with the genitalia on the ventral side and suckers on the dorsal side.

Ventrum:

Propodosoma and hystersoma each with 3 pairs of short setae and one pair of setae near the tip of the abdomen.

Legs:

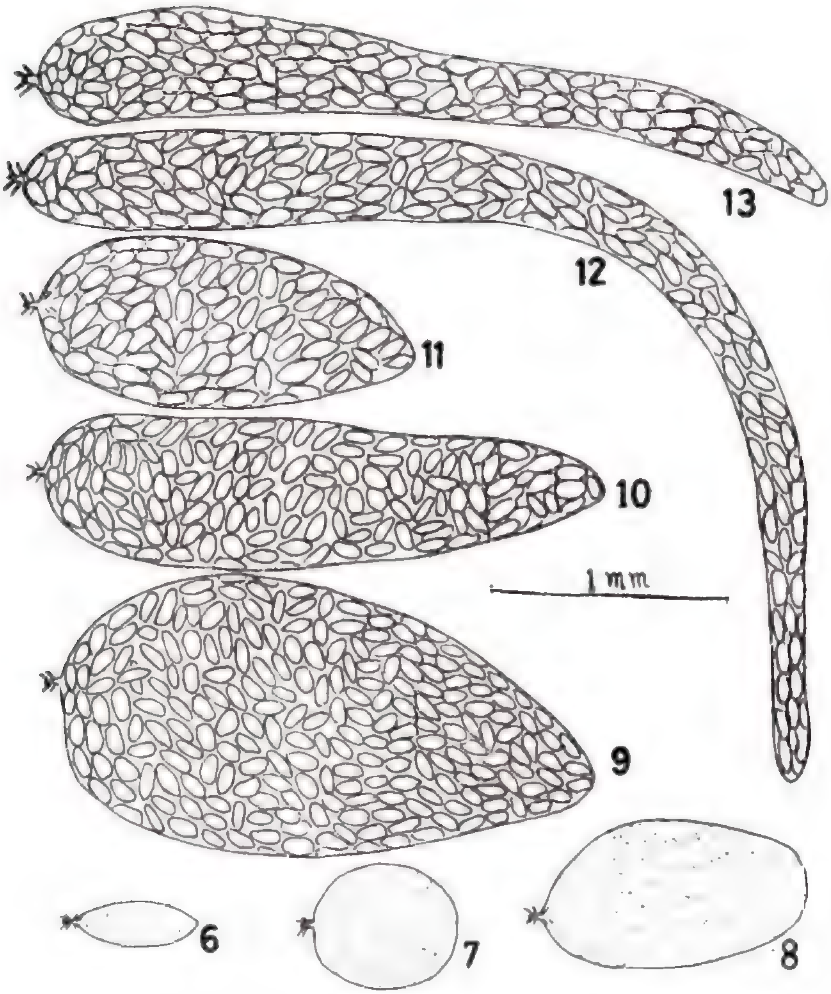
Leg I pointing forward, leg IV pointing backward and leg II and III projecting sidewards. The tarsi of the legs I and IV are blunt and bears a stout hooked claw. Tarsi II and III have bifid claws arising from slender pretarsus which are further expanded into bifid pulvilli.

Leg setation:

Leg I with trochanter fused with coxa, setation being, 1, 0, 4, 2, 3(2); leg II, 1, 0, 3, 1, 4, 6; leg III 1, 0, 2, 0, 4, 2 (1); leg IV 1, 0, 1, 1, 1, 2.

Types:

A holotype ♀ marked on slide, 6 paratype slides with ♀♀ and ♂♂, several slides with gravid females with eggs and developing mites on the abdominal sac; INDIA;



Figs. 6 to 13. various developmental stages of gravid females.

KERALA; Vellayani, 8.ix.1987, ex fallen buttons of *Cocos nucifera* (Palmaceae), M. Mohanasundaram Coll. (No. 37/87) TNAU.

The present species resembles *Xenaster longus* Mahunka (1970) in its non-gravid female form, but could be differentiated from it by having the smooth body surface; shape of the propodosoma; dorsal setal lengths; length of ventral setae; and the leg setation. This is the first record of this genus from the Indian region.

Remarks:

The mites were collected from fallen coconut buttons and found near the site of attachment of the buttons as well as below perianth parts. Later these were reared on fallen coconut buttons to study their biology and feeding behaviour. The observations indicated that these mites fed and developed on the fungal growth that occurred on the fallen and rotting coconut buttons.

Biological observations:

The female mites settled either sparsely or closely depending upon the suitability of the site. Only areas on the buttons near and around the site of attachment to the peduncle is preferred. This may be due to the softness of the tissue as compared to the distal part or due to availability of moisture. When perianth is present, the mites settled even on the inner side of the perianth. After settling, the abdomen of the mite distends in various shapes depending upon the space available, starting as a small globule, then pear shaped, then extending to a carrot shape. If the button is not dry, the development of the mite proceeds, even reaching a maximum length of 6 mm. The whole length of the abdomen is filled with the developing eggs. As the maturation is complete, the eggs develop into young females and males. By this time, the skin of the abdomen shrinks and breaks exposing the fully developed mites still covered over by the chorion. During this period, the reproducing female is crawled over by large number of young mites and releases them from the chorion. Male mites usually carry away virgin female mites for copulation. A mature reproducing mite attracts large number of young females and males around it. The process of fixation to the tissue, enlargement of the abdomen and completion of reproduction is finished within 4 to 5 days under laboratory conditions. As the buttons dry, the size of the development of the abdomen decreases, resulting in fewer individuals reproduced. Once the reproducing female gets fixed to the tissue and the abdomen starts enlarging, the mite is quite helpless and completely sessile, while the young females and males are quite active and always move about. In some instance the young mites may be seen actively moving inside the mother's body, through the thin transparent cuticle.

In a population of young mites, the males ranged from 8–10%. They are shorter in length and resembled males of other Tarsonemid mites. No morphological transformation occurred in male during their life cycle, while in the females, the abdomen enlarged up to a maximum of 300 times in volume which is unique in this species and not recorded in any other known acari. The abdominal size increase is dependant on the moisture content of the substratum on which the mite is fixed. If the substratum dries, the abdomen stops developing further and the eggs inside develop into young mites and come out after disintegration of the cuticle. Hence in this species we may come across reproducing females ranging in size from 1 mm to 6 mm; with various shapes of globule to carrot shapes.

The maximum number of eggs encountered in the hysterosomal sac of gravid female during the study under laboratory conditions was 160. These eggs develop simultaneously and when mature, they hatch within the sac under favourable conditions or hatch after the disintegration of the mother's cuticle.

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The author wishes to thank Dr. Marek Akliszewski, Department of Biology, University of Alabama, Tuscaloosa, USA, for kindly fixing the genus and for the supply of Mahunka's original description of the genus, and the drawings of the type species.

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PALATABILITY OF SOME MULBERRY VARIETIES TO SILKWORM

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Amongst seven varieties of mulberry viz., 'NS 2,' 'Sujanpur', 'Chak majra,' 'BC_2 59,' 'TR 10', 'Kanva 2' and 'Ichinose', maximum leaf consumption per worm in four hours (0.790g) was in 'BC_2 59' and minimum (0.449 g) in 'Chak majra' during IV instar. In V instar also, these two varieties gave maximum (0.999 g) and minimum (0.823 g) values. The pooled data indicated that consumption of 'BC_2 59' was 40 per cent more than that of 'Chak majra'.

(*Key words:* mulberry, silkworm, palatability)

INTRODUCTION

Silkworm (*Bombyx mori* L.) is an obligate feeder of mulberry leaves. It feeds continuously during five instars of larval period to spin cocoon. Cocoon characters, both quantitative as well as qualitatives, depend largely on the quantity and quality of leaves (KOUL, 1986, 1989; KOUL et al., 1979; DAR et al., 1988). In a specific variety of mulberry quality can be altered to some degree by appropriate practices. Quantity is purely physical attribute largely dependent on the management of rearing. Leaf consumption directly affects the silk producing capacity of the silkworm (MUTHUKRISHNAN et al., 1978). SUMIOKA et al. (1982) observed that leaf consumption influenced the body weight which in turn affects the silk output.

Palatability forms an important criterion for selection of new varieties of mulberry. Keeping this in view, the present study was made to check the palatability as a rate of leaf consumed per unit time by unit number of silkworms.

MATERIALS AND METHODS

Seven varieties of mulberry, viz., 'NS 2,' 'Sujanpur', 'Chak majra,' 'TR 10,' 'BC_2 59', 'Kanva 2' and 'Ichinose' were used. Uniform type of leaves were picked from 3 year old plants maintained at 30 cm height and 1 × 1 m distance. Intercultural practices were maintained uniformly in all the cultivars.

For the palatability check, silkworm race 'Jam 23' was used. Healthy post-third moult larvae were employed and divided into 28 batches of 50 worms each. 100 g mulberry leaves of individual varieties were fed to these worms, maintaining four replicates. After four hours worms were picked to determine the leaf waste in order to calculate the food intake. This process was repeated during 4th and 5th instar. The rearing temperature was 23° C and humidity was 75 per cent.

RESULTS AND DISCUSSION

The mean squares obtained under uniform conditions are significant. These indicate that palatability of different mulberry

varieties to silkworm larvae actually differed.

The mean leaf consumption per worm per four hours in two instars as well as pooled (Table 1) reveals that the different varieties differed in their consumption in both the instars. In the IV instar maximum leaf consumed was in variety 'BC_2 59' (0.790g) followed by 'TR 10' (0.762 g). Minimum leaf consumed was in variety 'Chak majra' (0.449 g). Similarly in the V instar maximum leaf was consumed in variety 'BC_2 59' (0.999 g) followed by 'Sujanpur' (0.970 g). Minimum value was obtained in variety 'Chak majra' (0.823g).

Relative leaf consumption amongst these seven varieties followed similar pattern in both the instars. It was highest in '$BC_2$59' and lowest in 'Chak majra' (base 10). Pooled data for the two instars also showed maximum consumption (0.895g) in '$BC_2$59' and minimum consumption (0.636g) in 'Chak majra'. Similar trend was evident in relative consumption (base 10).

The present observations indicate that the silkworm is sensitive to feeding on leaf of different mulberry varieties. This character can be effectively used while selecting the new mulberry varieties. Lower the rate of leaf consumption, higher number of silkworm larvae can be reared per unit quantity of leaf. KOUL (1986) reported least leaf ingestion in variety 'Ichinose' with best cocoon characters. Similar observations were later made by DAR et al. (1988). In the present case also, consumption of 'Ichinose' is next to the least consumed variety 'Chak majra' in both IV as well as V instar.

The rate of leaf consumption shows about two fold gain in V age over IV age, inspite of enormous increase in the body weight. Corresponding to rate of consumption, average leaf moisture percentage was highest

TABLE 1. Leaf consumption per worm (g) in IV and V instars in seven mulberry varieties.

Mulberry variety	Actual leaf consumption/worm/ 4 hours (g)			Relative leaf consumption/ worm/ 4 hours (g) (Base 10)			Average leaf moisture
	IV Instar	V Instar	Pooled	IV Instar	V Instar	Pooled	(%)
Kanva 2	0.514	0.962	0.763	1.312	1.519	1.482	63.71
BC_2 59	0.790	0.999	0.895	2.017	1.578	1.738	69.48
NS 2	0.472	0.858	0.665	1.205	1.355	1.292	68.20
Sujanpur	0.471	0.970	0.720	1.203	1.532	1.398	67.06
Ichinose	0.457	0.885	0.671	1.167	1.398	1.303	59.06
TR 10	0.762	0.833	0.797	1.946	1.315	1.548	69.31
Chak majra	0.449	0.823	0.636	1.146	1.300	1.235	68.17
CD at 1%	0.028	0.081	0.045	—	—	—	0.27
CD at 5%	0.021	0.059	0.033	—	—	—	0.19

(69.40%) in 'BC_2 59' and least (59.06%) in 'Ichinose'. This indicates the influence of water content on the leaf palatability. NARYANAPRAKASH et al. (1985) also reported food ingestion/digestion being dependent on dietry water content of leaves in addition to proteins and fats.

Pooled data show that on an average, consumption of 'BC_2 59' variety is 40 per cent more than that of 'Chak majra'. This also indicates that leaf requirement gets increased by half in the former variety, leading to an extra expenditure on raising of leaf by about half. In other words on a similar unit of land under mulberry cultivation, about one and half time more worms can be reared on variety 'Chak majra' as compared to 'BC_2 59'. involving uniform inputs. DAR et al. (1988) has also concluded that with a low ingestion rate, it is possible to rear increased number of silkworm larvae within a unit of quantity of leaf.

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EFFECT OF SYNTHETIC SEX PHEROMONE ON THE ACTIVITY OF THE SWEET POTATO WEEVIL

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Basic aspects like optimum concentration of pheromone to be used in field control, effective attraction range of sex pheromone in the field and temporal activity rhythm of sweet potato weevil males in the field were studied. Of the three concentrations of pheromone tried (0.25 mg, 0.5 mg and 1.0 mg) 1 mg attracted maximum number of weevils and efficacy of the pheromone declined after three months. Marked/recapture studies revealed that all the weevils released at 10 m distance were attracted to the pheromone source within 3 days. Trap catches indicated the weevil to be more active during 1800 hrs 0600 hrs in both May and October.

(*Key words:* synthetic sex pheromone, sweet potato weevil, attraction, diurnal and nocturnal activity)

INTRODUCTION

Utilization of synthetic sex pheromone for the management of sweet potato weevil (*Cylas formicarius* Fab.) is a recent technology in India. COFFELT *et al.* (1978) first reported that the female sweet potato weevil, *Cylas formicarius elegantulus* (Summers) produced a sex pheromone. They isolated the natural pheromone from the whole body extract of the virgin females.

Subsequently HEATH *et al.* (1986) isolated, identified, synthesised and bioassayed the active ingredient of the sex pheromone as (Z)-3-dodecen-1-ol(E)-2-butenoate. JANSSON *et al.* (1989) used this pheromone for monitoring sweet potato weevil in Southern Florida. A 95% pure compound, synthesized by MANI & MANGALAM NAIR of RRL (CSIR), Trivandrum was used in the present investigation.

Some investigations were carried out at the Central Tuber Crops Research Institute, Trivandrum, India during 1990-1991 and the results obtained are presented in this communication.

MATERIALS AND METHODS

Relative efficacy of different concentrations of pheromone:

The sex pheromone of SPW was impregnated in rubber tubes at three concentrations viz., 0.25 mg, 0.5 mg and 1.0 mg. To study their relative efficacy in trapping the male SPW, they were evaluated under field condition in infsted sweet potato field by using water trap (metal type) fabricated at the Central Tuber Crops Research Institute, Trivadrum (Fig. 1). The traps of 37.5 cm height (one each for each concentration of pheromone) were installed at different places in infested sweet potato fields @ one trap/100 m^2 area. They were installed on 10th December 1990 and retained in the field for a period of four months upto 9th April 1991. Detergent solution was used in the trap to avoid the escape of fallen male SPW. The locations of the

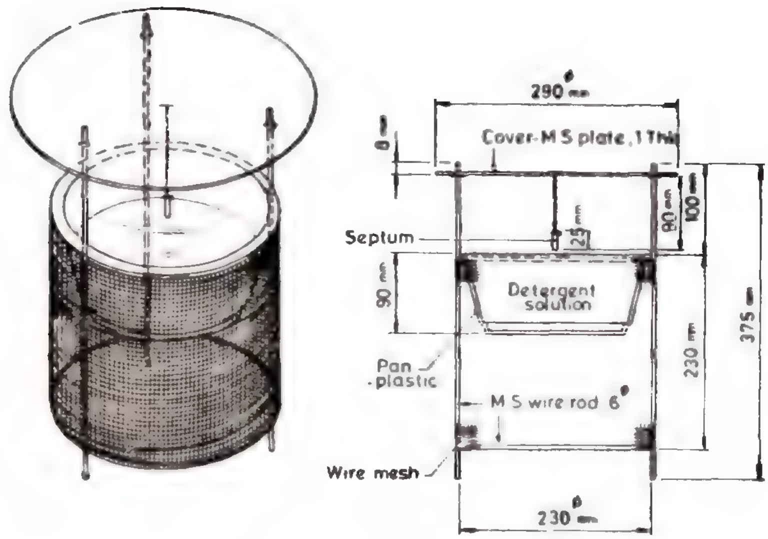

Fig. 1. The water trap.

traps were changed every alternate day after collection of the weevil and total collections per month per concentration were computed.

Distance of attraction of male weevil to pheromone source:

To find out the effective distance of attraction of weevil to pheromone source, the traps containing pheromone (1 mg) were installed in an extensive barren field with no sweet potato crop in the vicinity. The distances studied were 10 m, 25 m 50 m, 100 m and 200 m. Fresh male weevils (two days after emergence) from the laboratory culture were marked with bright coloured fluorescent paint on the elytra by using a fine needle. The marked male weevils were released at different distances such as 10 m, 25 m, 50 m, 100 m and 200 m from the pheromone source against wind direction. The release of marked weevils was done in the afternoon by monitoring the wind direction from the windwane installed in the field. The release for each distance was made independently at an interval of one week to avoid mutual interference. The number of marked insects trapped in the succeeding days were counted and the percentage worked out.

Nocturnal–diurnal activity of SPW:

To study the nocturnal–diurnal activity of SPW, traps containing 1 mg pheromone were installed in mature sweet potato field during May and October 1990. Three traps were installed in three different places in the farm wide apart from one another with a distance of more than 250 m for seven days and the number of male weevils trapped from 0600–1800 hrs and from 1800–0600 hrs were collected and counted.

RESULTS AND DISCUSSION

Relative efficacy of different concentrations of pheromone:

The number of weevils collected in the traps containing different concentrations of pheromone for a period of four months is presented in Table 1.

TABLE 1. Efficacy of different concentrations of pheromone to attract male sweet potato weevil.

Pheromone (mg)	No. of weevils/trap/month 1st	2nd	3rd	4th	Total	Per cent increase
0.25	2758	1336	345	251	4690	—
0.50	5657	1949	600	398	8604	192
1.00	9255	4544	2147	741	16,687	372

TABLE 2. Pheromone attraction range of sweet potato weevil.

Distance of release	No. released	No. of marked SPW recaptured 2nd day	3rd day	4th day	Total percent recaptured
10 m	100	88 (88%)	12 (12%)	—	100.0
25 m	75	53 (70.6%)	11 (14.7%)	—	85.3
50 m	100	22 (22%)	2 (2%)	—	24.0
100 m	135	—	12 (8.9%)	2 (1.5%)	14.0
200 m	100	—	5 (5%)	1 (1%)	6.0

It is evident from the data that as the concentration of pheromone increased more weevils were attracted to it and 1 mg pheromone tube was more suitable for mass trapping than the lower concentrations. Though the pheromone remained viable upto four months the efficacy declined after three months (Table 1). Hence it is desirable to change the tube after three months for mass trapping SPW.

Distance of attraction of male weevil to pheromone source:

Marked male weevil released at different distances from pheromone traps against wind direction in a barren field were attracted to pheromone from the next day of release upto fourth day. The percentage of recapture of marked insects at different distances from the pheromone source was as per Table. 2.

It is evident from Table 2 that at 10 m distance all the released weevil could be recaptured within three days. Further, as the distance increased the percentage of weevils recaptured decreased steadily recording lowest at 200 m distance (6%). The experiment has proved that within 10 m distance almost all available male

TABLE 3. Nocturnal and diurnal activity of SPW in different periods.

Treatment	Mean no. of weevels/trap/observation							Grand
	1	2	3	4	5	6	7	Mean
May 1990								
T1 (1800–0600 hrs)	41.3	15.0	22.7	11.3	36.7	21.0	14.0	23.1
T2 (0600–1800 hrs)	21.3	14.7	14.3	10.0	20.3	11.0	—	15.3
	CD for T1 & T2 at 5% = 6.63							
October 1990								
T1 (1800–0600 hrs)	87.0	126.5	155.5	258.5	252.5	361.5	76.5	188.3
T2 (0600–1800 hrs)	19.5	82.5	77.5	70.0	155.5	150.0	44.0	94.0
	CD for T1 & T2 at 5% = 51.5							

population could be attracted to the pheromone source. Hence for mass trapping of male weevils, the pheromone traps are to be installed at 10 m distance (1 trap/100 m^2 area).

Nocturnal-diurnal activity of SPW:

The data collected on nocturnal-diurnal activity of male SPW during May and October 1990 are presented in Table 3.

The number of weevils collected per trap during 1800–0600 hrs in May ranged from 21 to 41 with a mean 23.1 and in October from 87 to 362 with a mean of 188.3, whereas during 0600–1800 hrs the collection ranged from 11 to 21 with a mean of 15.3 in May and 44 to 156 with a mean of 94.0 in October showing more weevils/trap during night. The analysis of variance (F–test) showed that T1 is significantly superior to T2. JANSSON *et al.* (1989) reported that mean weevil count in plastic funnel trap in a commercial sweet potato field in Southern Florida ranged between 2 and 5785 per trap per night and the count during day time was not reported by them. In the study conducted by JANSSON *et al.* (1989) the species involved, pest density, ecological conditions prevailed, cropping pattern, concentration of pheromone and trapping devices were entirely different from that of the present study. Results in Table 3 in this study indicate that the weevil is more active during 1800–0600 hrs irrespective of the season.

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ANTI-PREDATOR STRATEGY OF LARVAL AGGREGATION PATTERN IN *ASPIDOMORPHA MILIARIS* (CHRYSOMELIDAE : COLEOPTERA)

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The larvae of a tortoise beetle, *Aspidomorpha miliaris* (F.) (Coleoptera : Chrysomelidae) remain in clusters, each in the form of a disc during resting periods. Most of the members of a cluster react synchronously by moving the tip of their exuviae attached to their tail upward to any object approaching them thereby simulating a giant spider. During midday feeding, the larvae disperse and arrange themselves in a linear fashion. The palatability of the larvae to probable predators available in their environment, was tested by offering the larvae individually as well as in natural clusters to lizards, birds, mantids and spiders. The larvae were found to be unpalatable to lizards, birds and mantids probably because of their feeding on toxic plants, *Ipomoea fistulosa* Mart, ex. Spiders were found to prey on an isolated larva but not on a cluster. The grubs in cluster appeared to evade predation by spiders by a sort of cooperative mimicry simulating the form of a giant spider.

(*Key words*: Chrysomelidae, *Aspidomorpha miliaris*, tortoise beetle, palatability, larval aggregation, spider as predator)

INTRODUCTION

While walking in a garden one of us (N.S.) noticed what appeared to be a giant spider on an *Ipomoea* leaf, which on closer observation was found to be a group of insect larvae. This prompted the present investigation into the spectacular spider form assumed by a group of beetle larvae. Although various types of insects show aggregation (Ibbotson & Kennedy, 1951; McEvoy, 1979) at some stage of their life cycle, very few of them show a specific and consistent pattern. The larvae of *Aspidomorpha miliaris* aggregate on the lower surface of the leaves of *Ipomoea fistulosa* (Convolvulaceae) in a discoidal pattern (Chattopadhyay & Sukul, 1988). The purpose of the present investigation is to find out the nature and significance of this specific pattern of aggregation. *I. fistulosa* grows all over India in varied ecological conditions. The plants are not eaten by cattle and are known to contain two toxic principles (Chopra & Chopra, 1969).

MATERIAL AND METHODS

Field observation:

The present study was conducted in the village Nalahati where a large number of naturally growing *Ipomoea* plants were found. This village is situated in P. S. Dainhat, Sub-Division Katwa, District Burdwan of West Bengal. Twenty colonies of the larvae on *Ipomoea* leaves were kept under observation continuously until they grew into adults. The plants were also grown in pots and kept in an experimental garden for continuous observation. Cocoons containing eggs were kept on the leaves of the plants which were later

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colonized by emerging larvae. The observation was continued for 4 years. Larval aggregations were studied with respect to the following parameters: 1. The shape, size and composition of a larval cluster; 2. Reaction of the larvae in a cluster to an approaching object; 3. Any change in the pattern of a cluster with respect to the circadian rhythm.

Determination of palatability of the larvae to probable predators:

The larvae were presented individually as well as in a natural cluster to the following predators available in their environment: a garden lizard, *Calotes versicolor* Boulenger; birds, *Acridotheres tristis* Linn., *Turdoides striatus* Dumont., a mantid, *Eumantis* sp. and spiders, *Araneus mitifica* (Simon), *Clubiona ludhianaensis* Tikader and *Cheiracanthium* sp.

The larvae were presented to at least 3 individuals of each species of a predator used and the presentation was repeated 10 times at suitable intervals for each individual. A χ^2 test was performed to compare the number of successful attempts at feeding by a predator on an isolated larva with that on a larval cluster.

RESULTS AND DISCUSSION

Field observation:

The larvae arranged themselves in a ring on the under surface of *Ipomoea* leaves with posterior ends containing exuviae pointing outward and upward. The pattern seemed to simulate a giant spiny spider hanging on an invisible net behind a leaf (Fig. 1). The members of a cluster varied widely in number and were arranged in a single or in two concentric rings. The single ring aggregation contained 9 to 11 individuals and the double one 6 to 40 individuals. The larvae displayed the discoidal pattern of aggregation only during the resting period throughout the night and also part of a day. They dispersed from the disc pattern and

TABLE 1. Feeding response of differet predators to the larvae of *Aspidomorpha miliaris* offered singly and in a natural cluster.

Predators used	No. of individuals of each predator	No. of successful attempts at feeding per individual predator with S.D.*	
		Larval cluster	Individual larva
Calotes versicolor	6	0	0
Acridotheres tristis	5	0	0
Turdoides striatus	5	0	0
Eumantis sp.	3	0	0
Araneus metifica	5	0	9 ± 0.632**
Clubiona ludhianaensis	5	0	9 ± 0.489**
Cheiracanthium sp.	4	0	9 ± 0.707**

* Each individual predator was given 10 chances.

** Significant at 0.0001 by χ^2 test.

Fig. 1. A group of *Aspidomorpha miliaris* larvae in the form of a giant spider.

fed on the leaves of *I. fistulosa* in a linear or semi-circular row during midday (Fig. 2). The earlier stages were seen to feed even during morning hours. After feeding, the larvae regrouped themselves into discs and this regrouping might not bear any membership relation to their former groups.

The eggs were laid from March to August in membraneous cases simulating a curled dry leaf (Fig. 3). Eggs hatch into larvae in 2 weeks. Usually 30–60 larvae emerged from each cocoon. They remained together immediately after emergence but did not form any consistent pattern. In 24 hrs they formed a single disc. At this time they started feeding. In 3 to 4 days they broke up into 3 or 4 groups. Predation was observed at this stage and the number of larvae declined rapidly every day. A pentatomid bug was once seen feeding on an individual larva in nature. Larvae developed into adults in 4 weeks depending on the temperature. The duration was longer with isolated larvae. The pupae did not form any fixed pattern.

Most of the larvae in a colony responded synchronously to any approaching object by moving the tip of their exuviae attached to their tail upward and inward.

Experiment with predators

The results of feeding experiments with predators are given in Table 1. The lizards, birds and mantids did not attempt to feed

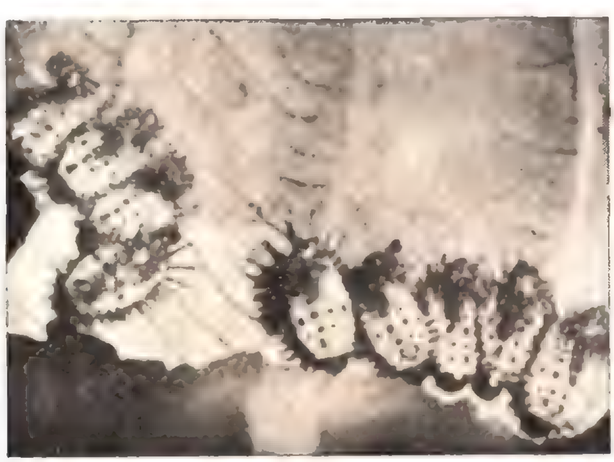

Fig. 2. Feeding of an *Ipomoea* leaf by *Aspidomorpha miliaris* larvae.

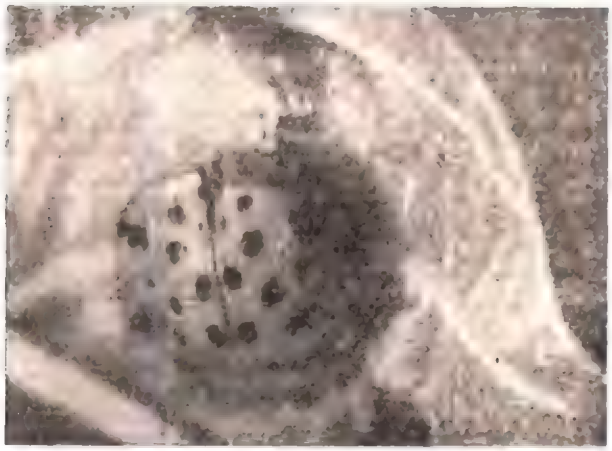

Fig. 3. *Aspidomorpha miliaris* female laying eggs in a cocoon.

on the larvae presented before them individually or in a cluster. All three species of spiders preyed upon the larvae by sucking their body fluid whenever the latter were presented before them individually (Figs. 4, 5). The spiders never preyed on the larvae in a cluster and they moved away from the cluster. The number of successful attempts at feeding on an isolated larva as compared to that on a larval cluster is highly significant (Table 1, $P<0.0001$, χ^2 test). The carcasses of individual larvae covered with spider webbing were observed on *Ipomoea* leaves in nature (Fig. 6). This shows that spiders are natural enemies of those larvae.

The larvae appeared to be unpalatable to lizards, insectivorous birds and preying mantids probably due to the toxic substances of their food plants, *I. fistulosa*, stored in their body. It is evident from the results that the chrysomelid larvae were palatable to some spiders and a pentatomid bug.

Fig. 4. A spider attacking a single *Aspidomorpha miliaris* larva.

Fig. 5. The same spider spinning its thread around the same larva.

The larvae might evade predation by assuming the discoidal pattern which looks like a giant spiny spider both from the side as well as from the top view. Chrysomelid larvae of another species are known to protect themselves from predators by a multispined, waxy, outgrowth of cuticle unpleasant to predators (O'Toole & Preston-Mafham, 1985). Besides their appearance, the spider mimicry in the present case is further suggested by the synchronous movement of the exuviae attached to the tails of the larvae in a cluster. The reaction of the spiders to larval clusters is suggestive

Fig. 6. Carcasses of *Aspidomorpha miliaris* larvae covered with spider nets.

of the fact that they do not identify their prey in a cluster and rather tend to avoid it. This avoidance might not be due to the size of a larval cluster because the spiders were found to prey on butterflies which were bigger than a larval cluster. The protective discoidal pattern seems to be interesting in the sense that it is of a co-operative type being produced by a group of individuals.

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We thank the Director, Zoological Survey of India, Calcutta, for the identification of the tortoise beetle and spiders.

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A NEW SPECIES OF GENUS *CTENUS* WALCKENAER (ARANEAE : CTENIDAE) FROM INDIA

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A new species of spider *Ctenus dangsus* sp. nov. (Ctenidae) is described and illustrated from Waghai, Dist. Dangs, Gujarat, India.

(*Key words:* *Ctenus dangsus* sp. nov. (Ctenidae) from India)

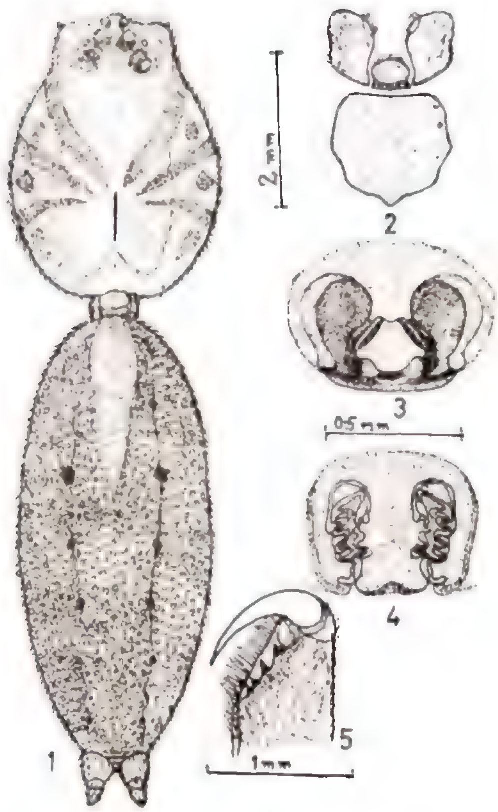
The spiders of this small family Ctenidae are separated from its very close members of Clubionidae and Lycosidae because of the peculiar arrangement of their eyes which are forming three rows. Very few Indian *Ctenus* species are described by previous workers, viz., Simon (1904), Cambridge, F.O.P. (1897, 1902), Gravely (1931) and Tikader (1973, 1976). Recently Tikader and Malhotra (1981) described one form from Arunachal Pradesh and Patel and Reddy (1988) described two species from Coastal Andhra Pradesh, India. While examining the spider collections made by one of us (BHP) from Gujarat, we came across a new species of *Ctenus* which is described and illustrated here, making the total number of species to twelve from India. Out of the two genera of the family represented from India, *Ctenus* is widely distributed, while *Acanthesis* Thorell is represented only from Kavali, Cochin and Ooty, Nilgiri Hills, Tamil Nadu by *A. indicus* Gravely.

The type specimens will in due course be deposited in the National Collections of Zoological Survey of India, Calcutta.

Ctenus dangsus sp. nov. (Figs. 1–5).

General: Cephalothorax and legs reddish brown, abdomen light brown. Total length 9.60 mm. Carapace 3.50 mm long, 2.60 mm wide; abdomen 5.75 mm long, 2.49 mm wide.

Cephalothorax : Longer than wide, narrowing anteriorly, clothed with pubescence and some hairs. Thoracic region provided with a black conspicuous fovea in the centre. A light brown longitudinal band is present extending from ocular area to the base of cephalothorax. Very thin brown streaks are radiating from near the fovea to all the sides except the anterior and posterior sides. Both rows of eyes recurved but anterior row strongly recurved, so that the anterior laterals come in the line of posterior medians, thus forming three rows of eyes. Anterior laterals are situated in front of posterior laterals. Anterior medians are larger than anterior laterals, posterior eyes equal in size. Except anterior laterals, all eyes are encircled with black patches. Ocular quad longer than wide, slightly wider behind than in front as in Fig. 1. Sternum nearly oval, slightly narrower behind, light brown, clothed with



Figs. 1–5: *Ctenus dangsus* sp. nov. 1. Dorsal view of female (legs omitted); 2. Sternum, labium and maxillae; 3. Epigyne; 4. Internal genitalia; 5. Right chelicera, inner view.

hairs and pubescence. Labium very slightly longer than wide, distal end pale with few hairs. Maxillae yellowish in colour and provided with scopulae at the anterior ends. Sternum, labium and maxillae as in Fig. 2. Chelicerae moderately stout; promargin with three teeth and retromargin with four unequal teeth as in Fig. 5. Legs thin and long. Tibiae and metatarsi I and II provided with five and three pairs of ventral spines respectively. Tibiae III and IV with three pairs of ventral, three dorsal, two prelateral and two retrolateral spines; metatarsi III and IV with three pairs of ventral, three spines each on dorsal, prolateral and retrolateral sides. Leg formula 4 1 2 3.

Male: Unknown.

Abdomen: Elongate, longer than wide, yellowish brown, clothed with pubescence. Dorsum of abdomen middorsally provided with a yellowish white longitudinal band extending for the entire length with six pairs of light yellow spots on its margin as in Fig. 1. Ventral side lighter than the dorsal, clothed with pubbscence. Epigyne and internal genitalia as in Figs. 3 and 4.

Holotype: One female in spirit.

Type-locality: Waghai, Dist. Dangs, Gujarat, 15.viii.1984. Coll. B. H. Patel.

Etymology: The name refers to the District name of the type-locality.

Diagnosis : This species resembles *Ctenus tuniensis* Patel and Reddy but it is separated as follows: (i) Chelicerae moderately short, promargin with three teeth and retromargin with four unequal teeth but in *C. tuniensis* promargin with three teeth and retromargin with five unequal teeth. (ii) Dorsum of abdomen middorsally provided with a yellowish white longitudinal band extending for the entire length with six pairs of light yellow spots on its margin but in *C. tuniensis* dorsum of abdomen middorsally provided with a white longitudinal band extending for the entire length with seven pairs of light yellow spots on its margin. (iii) Epigyne and internal genitalia are also structurally different.

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OBSERVATIONS ON SWARMING BEHAVIOUR OF THE TERMITE *EREMOTERMES PARADOXALIS* IN JODHPUR (INDIA)

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Observation on swarming of the termite *Eremotermes paradoxalis* Holmgren were made in the field at Jodhpur. On one occasion a very interesting observation of swarming was observed from one hole from which alates with damaged wings were issuing continuously for 25 minutes. The wings were evidently nibbled by the workers thus inducing the stoppage of reproduction as the alates could not fly and cast their wings off and did not mate. It is conjectured that the nibbling activity may be an innate machanism for population control perceiving the ensuing drought conditions. After swarming alates exhibited tandem coupling behaviour. During swarming, predators were observed devouring imagoes.

(*Key words*: *Eremotermes paradoxalis*, swarming, tandem and nibbling behaviour, predators)

Two species of *Eremotermes* (Termitidae: Amitermitinae) occur in the Jodhpur region (Western Rajasthan) viz., *E. paradoxalis* Holmgren and *E. neoparadoxalis* Ahmad, the former being more common. Extensive biological observations on *E. paradoxalis* were made by ROONWAL & RATHORE (1974) and RATHORE (1977). Whereas swarming of winged adults and associated activities in Isoptera as a whole have been reviewed by NUTTING (1969), the same for the Oriental species have been reviewed by ROONWAL (1970). In the present paper new observations on the swarming behaviour of *E. paradoxalis* are presented.

Field observations were made at Jodhpur on 5th August 1990 and were again repeated during 1991 from the same colony and locality during pre-monsoon and monsoon periods. A large number of alates from swarms and from various emergence holes were collected for further studies.

Swarming: First swarming of the reproductives of *Eremotermes paradoxalis* usually takes place at Jodhpur with the first premonsoon heavy shower usually during last week of June (ROONWAL & RATHORE, 1974; RATHORE, 1977). There are about 5 to 6 swarms in a year and swarming continues for a period of 11 weeks (17th May to 5th August) during pre-monsoon and monsoon seasons. However, a very early swarming was observed in the third week of May 1979. The swarming generally occurs in late afternoon and early evening (before 8.30 p.m.). The weather during swarming is usually very calm, hot and sultry, but often it may be cloudy.

A very interesting and bizzare episode of swarming was observed on 5th August 1990 at Jodhpur in the same colony which remained under the author's observation for the last twenty years. On the day there was a good shower in the morning and as usual in the evening at 5.30 p.m.

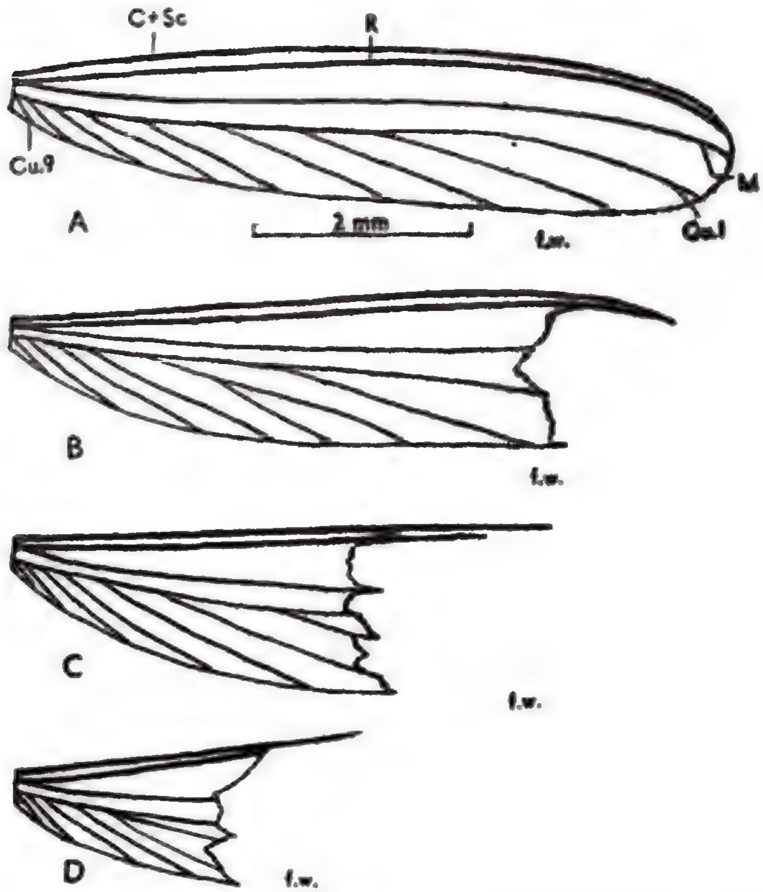

Figure 1. *Eremotermes paradoxais* 1. Outline of right fore wing and its venation. Cu. 1 and Cu. 9 Cubitus; M. media; Rs, radial Sector, Sc + R, Subcosta + radius. 2. Outline of right fore wing with 25% damage. 3. Outline of right fore wing with 50 % damage. 4. Outline of right fore wing with 75% damage.

Alates started emerging from tiny holes in the ground, initially in one or two's and later on in four and fives. The swarming hole was guarded by soldiers and workers from inside. The swarming alates crawled to some distance and tried to take off but failed to fly. All of them made several attempts but failed to be airborne. On observing closely it was found that swarming alates issued from a particular swarming hole for 25 minutes carried damaged wings (Fig. 1). The damage of wings varied from 25 to 75 per cent of total wing surface (Fig. 1).

After coming out of the emergence hole alates generally fly for an hour or so and descend to ground, twist and turn the body to cast off their wings. But in this particular swarming episode where all the alates possessed damaged wings, they could not fly. Instead they ran here and there and continuously tried to twist and turn their body to cast off their wings, but failed to do so because without flying, the wing muscles could not get enough stimulation to detach the wing membrane at the region of humeral suture. The alates with damaged wings also exhibited tandem behaviour; male

termites actively ran and follows the females, sometimes touched the last abdominal segment. When a male during this follow-up action lost its contact with the female, it was observed that it started moving aimlessly very fast here and there and showed a very peculiar behaviour of jerking, jumping and turning its body upside down and rolling in this position for few seconds. After that it again came back to its original normal position. Some of the females also showed a very interesting behaviour of raising their abdomen at an angle of 90° and remained motionless, probably a "calling" signal to males. When these alates failed to cast off their wings the individuals were collected, out of 188 alates 102 ♂ and 86 ♀ were observed, the sex-ratio being 54 ♂♂: 46 ♀♀.

Predators:

The swarming alates were actively preyed upon by the large black ant (*Camponotus compresus*), house sparrow (*Passers domesticus*), Indian robin (*Saxicoloides fulicata*), hoopoe (*Upupa epops*), garden lizard (*Calotes versicolor*), house lizard (*Hemidactylus flaviviridis*) and toad (*Bufo andersoni*).

It is rather difficult to assign a reason for the unusual nibbling behaviour of workers. Swarming is a natural process, the nymphs develop wings and swarm mainly for mating with genetically diversified groups, and for species dispersal. With this contention the question arises as to why the wings were nibbled in a way to stop the swarming, breeding and spatial distribution. During 1990, when this unusual incident was observed on 5th August 1990, rainfall during May and June was minimal but the majority of the rainfall arrived during the first fortnight of July and August. Thereafter more or less drought conditions prevailed. There is a likelihood that the subsequent relative drought conditions, prevailing soon after the day of incident were responsible for the behaviour of workers, nibbling the wings of alates. If the termites enter into the swarming phase and reproduce the survival of young may be of a poor order and hence, having perceived the future drought, the reproductive activity was stopped. If this conjecture is plausible, it may be an inbuilt mechanism in termites to inhibit the reproductive activity when the condition for survival of the next generation is not favourable.

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PANIMERUS KALATHENSIS A NEW SPECIES FROM INDIA (PSYCHODIDAE : DIPTERA)

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The genus *Panimerus* includes a small group of homogenous species reported mostly from Palaearctic region. Only one species of this genus, *Panimerus idukii* Ipe & Kishore has so far been reported from Idukii (Kerala) in India. The description of a second species collected from Himachal Pradesh (India) is given in the paper.

(*Key words:* new species, Psychodidae, *Panimerus kalathensis*)

Panimerus Eaton is a very distinct genus with closely inter-related species showing a unique combination of antennal, male genitalic and wing venational characteristics. The type species of the genus, *Panimerus notabilis* Eaton, was first described by Eaton in 1983 as *Pericoma notabilis* and transferred by the same author to *Panimerus* Eaton in 1913. Tonnoir in 1919 transferred it to *Telmatoscopus* Eaton. Duckhouse in 1962 also treated it under *Telmatoscopus*. Ipe I. M., Agnes Ipe and Ram Kishore described a species *Panimerus idukii* in 1986. *Panimerus kalathensis* is the second species of *Panimerus* recorded from India, collected from Kalath (Manali) Dist. Kulu in Himachal Pradesh (India).

The genus *Panimerus* Eaton can be identified by using a combination of characters like antenna with flagellar segments mostly flask shaped, wings with either radial or medial or one of the forks always present, hairs never on wing membrane, eye bridges, separated with an inter-ocular space and ascoids being finger shaped.

* Contribution No. 341 From School of Entomology.

The known Indian species *Panimerus idukii* Ipe and Kishore and *P. kalathensis* can be separated by the number of retinacula on the cercopods, *P. idukkii* with 30 retinacula and *kalathensis* with a single incurved retinacula.

Panimerus kalathensis:

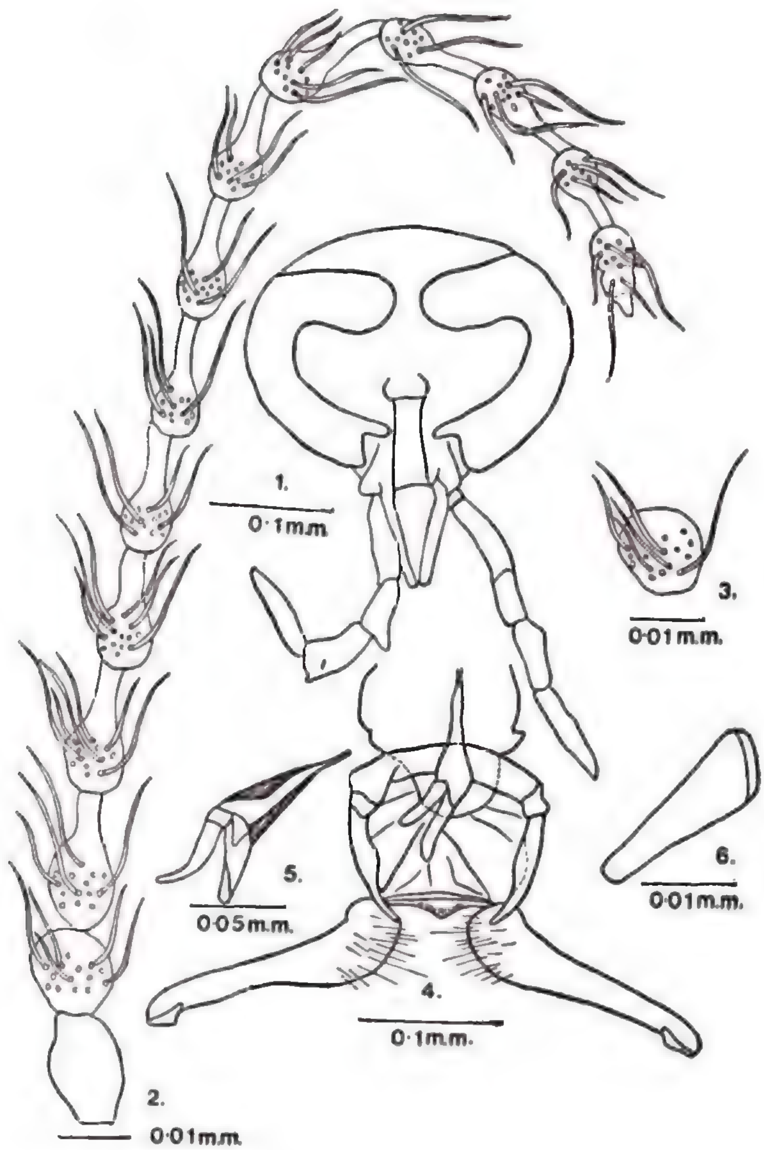
Male:

Head:

Eye bridge moderate not continuous, 5 rows of facets, interocular space 1/12 of the vertical height of eye, interocular sulcus well formed, arms bent forming an angle of 110°. Palpi four segmented, segmental ratio length 2:2:5:2:3 from the basal segment. Labella bulbous, distinct clypeal sclerotization; antenna with 16 segments, segments flask shaped, bears rows of bristles. Ascoids digitate, inner edge of the eye with a stalk like projection, a prominent characteristic feature of the species.

Wing:

Wing 2.14 mm long and 1.03 mm wide, apically pointed, costa reaching two thirds



Panimerus kalathensis Male: 1. Head; 2. Antenna; 3. Ascoid; 4. Genitalia; 5. Sperm pump; 6. Retinacula;

of the wing length. Radial and medial fork well formed, medial fork basal to the radial fork, R_5 ending beyond the wing apex, hairs present on the veins, membrane clear.

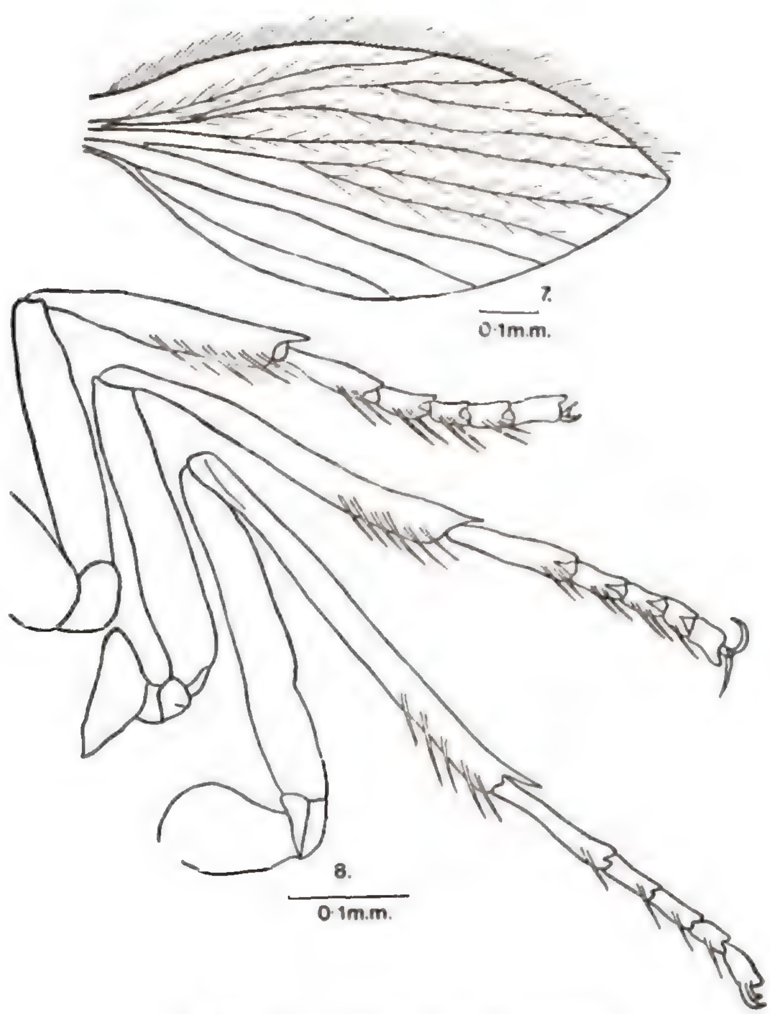
Legs:

Slender, claws simple; ratio of fore mid and hind legs are as following:

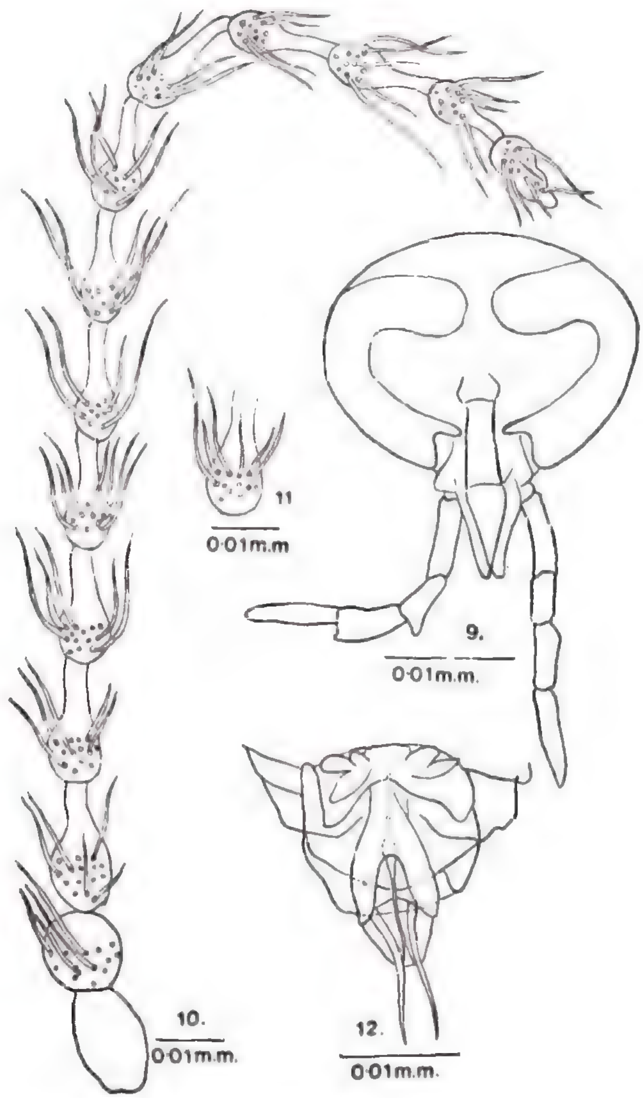
	F	T	Ta_1	Ta_2	Ta_3	Ta_4	Ta_5
Fore leg	3.00	3.00	1.00	0.72	0.50	0.42	0.40
Mid leg	3.00	3.00	1.05	0.78	0.40	0.35	0.48
Hind leg	3.00	4.00	1.00	0.72	0.50	0.52	0.40

Genitalia:

Aedeagus symmetrical, simple; median rod broad, coxite two times as long as wide. Style apically pointed and more than six times as long as wide; cercopods long about eight times as long as wide, incurved with only single retinacula at the tip, an important characteristic feature of the species compared to the group of retinacula on cercopods of the species.



7. Wing; 8. Legs, fore mid and hind leg.



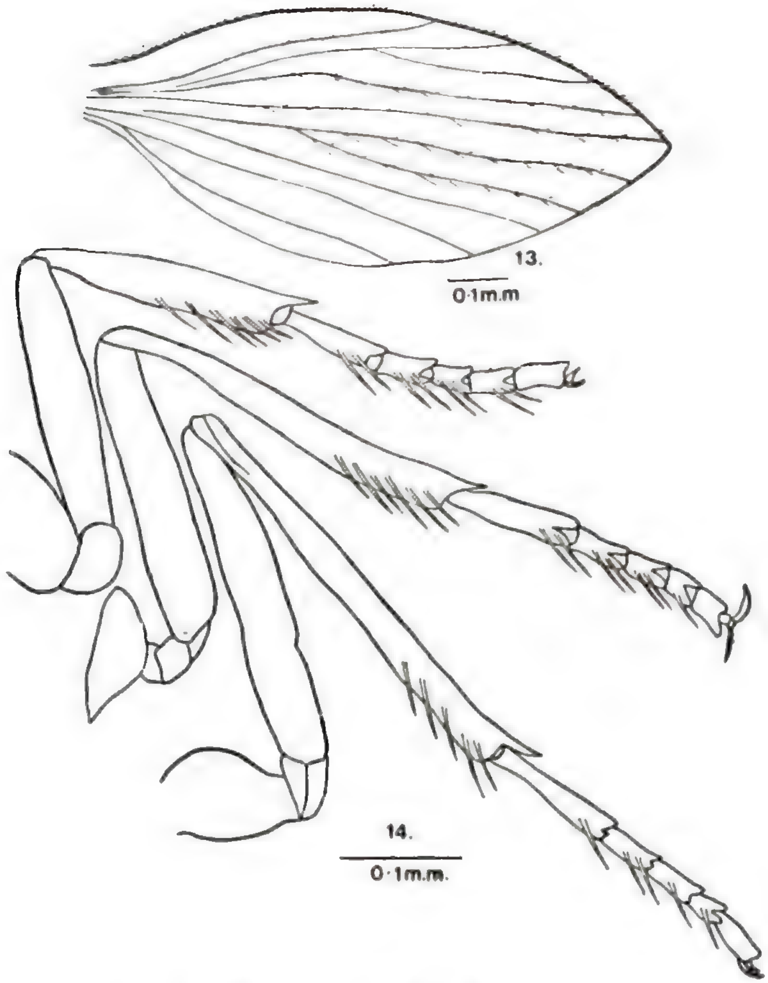
Female *Panimerus kalathensis*: 9. Head; 10. Antenna; 11. Ascoid; 12. Genitalia;

Female:

Subgenital plate broader than long, depressed on inner and outer ends, cerci longer, apically blunt.

Holotype:

Male, on slide Coll. Naveen S. Singh 17. viii. 1991 Kalath/Manali (2050 MSL) Dist. Kulu, Himachal Pradesh (India).



13. Wing; 14. Legs. Fore mid and hind leg.

Paratypes:

4 males on slide data same as holotype, 5 females on slide, Coll. Dinesh Lal 13. ix. 1991 Kalatop Rest House (2460 MSL) Dist. Chamba, Himachal Pradesh (India).

Panimerus kalathensis resembles *P. idukii* in having moderate eye bridge, radial and medial forks well formed and medial fork being basal to radial fork. It differs in having only one retinacula compared to the 30 in *P. idukii* Ipe and Kishore and 9 in *P. notabiles* Eaton.

The species appears to be a hipsobiont both collection localities as Manali (2040 MSL) and Kalatop (2460 MSL) are on higher elevations with colder weather and also the flies were collected from wet moist surfaces. The nomenclature is derived from the place of collection 'Kalath'.

ACKNOWLEDGEMENT

Authors are grateful to the Principal, St. John's College, Agra for facilities for work. Assistance extended by Dr. Santokh Singh, Dr. (Mrs) AGNES IPE, Mr. DINESH LAL is gratefully acknowledged. Financial assistance for the work was provided by the Department of Science and Technology.

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A NEW SPECIES OF GENUS *CHELONUS* PANZER (HYMENOPTERA : BRACONIDAE) FROM INDIA

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(*Received* 30 *January* 1993)

***Chelonus* (*Chelonus*) *deogiri*, sp. nov. is described and key to the Indian species of *Chelonus* (*Chelonus*) is provided for the first time.**

(*Key words:* new species of *Chelonus*, *Hymenoptera*, *Braconidae*)

Chelonus is a moderate sized genus belonging to the subfamily Cheloninae of the family Braconidae. Panzer (1806) erected this genus with *Ichneumon oculator* Fabricius as type species. *Chelonus* is divided into two subgenera *viz.*, *Chelonus* Panzer and *Microchelonus* Szepligeti. The earlier work on the Indian species of *Chelonus* (*Chelonus*) are by Subba Rao (1955), Gupta (1955) and Rao and Chalikwar (1971)

In the present work one new species, *Chelonus* (*Chelonus*) *deogiri* is described and a key to the Indian species of *Chelonus* (*Chelonus*) is provided for the first time.

The type material of the species is in the collection of the junior author for the time being and will be deposited in the National Collection of Zoological Survey of India, Calcutta.

Chelonus (Chelonus) deogiri, sp. nov.
(Figs. 1–3)

Female: Body (Fig. 1) 5.7 mm. Head (Fig. 2) 0.4 times as long as wide, 2.5 × as wide as long; vertex strigoso-rugose, pubescent; interorbital space 0.6 times the ocellocular space; occiput smooth, pubescent, margined; frons without median longitudinal carina, reticulato-rugose, punctate, pubescent; face 0.65 times as long as wide, rugoso-reticulate, punctate, pubescent with median longitudinal carina; clypeal fovea distinct; clypeus 0.7 times as long as wide, subpolished, closely, deeply punctate, pubescent; mandible bidentate, stout, weakly, shallowly punctate, pubescent; 2 × as long as basal width malar space 1.3 × as long as basal width of mandible; temple broad, 0.45 times as long as height of the eye, longitudinally strigoso-reticulate to rugose, pubescent; eye 2.30 × as long as wide, pubescent; antenna 2 + 24 segmented; scape 2.15 × as long as wide; postpedicel 3 × as long as wide; penultimate segment 0.65 times as long as wide; terminal segment as long as wide; maxillary palpi 5 segmented.

Thorax 1.35 × as long as wide; pronotum rugose, closely, deeply punctate, pubescent mesoscutum rugoso-reticulate, without median ridge, with foveolae, pubescent; notauli indistinct; mid-apical region transversely strigoso-reticulate, punctate,

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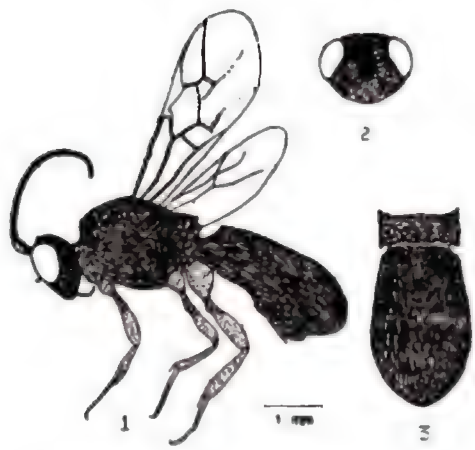

Chelonus (*Chelonus*) *deogiri*, sp. nov.
Fig. 1. *Chelonus* (*Chelonus*) *deogiri* female: Fig. 2. Head.
Fig. 3. Propodeum and abdomen.

pubescent; disc of scutellum slightly convex, rugoso-reticulate, pubescent, with lateral depression; scutellar furrow with distinct transverse carinae; pronotum rugoso-reticulate, foveolate, pubescent; propleurum punctate; mesopleurum rugoso-reticulately punctate, pubescent; mesopleural suture distinct; mesosternum rugoso-reticulate, foveolate, pubescent; metanotum shiny, with a distinct crenulated furrow; propodeum (Fig. 3) reticulately rugose; propodeal crest distinct. Hind coxa globose, as long as wide; trochanter I 2 × as long as wide; femur 3 × as long as wide; tibia 1.25 × as long as femur and 5 × as long as wide; tibial spur 0.5 times as long as basitarsus; basitarsus 0.4 times as long as tibia.

Fore wing 2.7 × as long as broad; stigma 2.4 × as long as wide, slightly longer than radial cell on wing margin; third abscissa of radius as long as stigma; first abscissa of radius 0.7 times as long as width of stigma; second abscissa of radius slightly shorter than first abscissa; nervulus distad, inclivous, 0.7 times as long as width of stigma; hind wing 3.5 × as long as broad; mediella as long as basella; radiella and cubitus unpigmented; nervellus reclivous, as long as basella.

Abdomen broadly sessile, apex rounded, 1.55 × as long as wide, shorter than head and thorax combined, longitudinally strigoso-reticulately rugose at basal 0.4 region becoming rugoso-reticulate, pubescent; carapace with two basolateral yellowish-white spots, ovipositor short, as long as ovipositor sheath, as long as hind basitarsus.

Black. Apical region of mandible, distal portion of femur, tibia, tarsus and claw yellowish-brown; stigma veins blackish-brown; wings hyaline; two yellowish-white spots on baso-lateral sides of the carapace.

Male: Unknown

Holotype : ♀, INDIA : MAHARASHTRA : Aurangabad, 12.x.1990, reared on *Heliothis armigera* by S. N. Ambekar. Antenna, wings, and legs mounted on slides and labelled as above.

Remarks: In accordance with the key to the Indian species of *Chelonus* (*Chelonus*) provided here the new species, *Chelonus*

(*Chelonus*) *deogiri* superficially resembles the Indian species *Chelonus* (*Chelonus*) *dwibindus* Rao and Chalikwar (1971) but is distinguished from the same in the following characters: (i) vertex strigosorugose, (ii) clypeus closely, deeply punctate, (iii) antenna 26 segmented, (iv) terminal segment of antenna as long as wide, (v) malar space 1.3 × the basal width of mandible, (vi) temple longitudinally strigoso-reticulate to rugose, (vii) mesoscutum without median ridge, (viii) tibia 1.25 × as long as femur, (ix) abdomen strigoso-reticulately rugose and (x) ovipositor as long as hind basitarsus.

The new taxa superficially resembles the other Indian species *Chelonus* (*Chelonus*) *narayani* Subba Rao (1955) but differs from the same in the following respects: (i) vertex strigoso-rugose, (ii) clypeus closely, deeply punctate, (iii) frons and face reticulately rugose, (iv) antenna 26 segmented, (v) disc of scutellum slightly convex, (vi) propodeum reticulately rugose and (vii) abdomen strigoso-reticulately-rugose.

KEY TO THE INDIAN SPECIES OF *CHELONUS* (*CHELONUS*)

1. Clypeus, face, frons vertex closely transerversely rugulose; female antenna 24 segmented; carapace entirely closely rugulose. Vertex more coarsely punctate .... *narayani* Subba Rao, 1955.
   Clypeus, vertex differently sculptured; female antenna more than 24 segmented; carapace differently sculptured 2
2. Vertex deeply, reticulately rugose; female antenna 25 segmented, terminal segment 2 × as long as wide; malar space 1.5 × the basal width of mandible; temple reticulately rugose; carapace reticulately rugose; ovipositor 1.5 × as long as hind basitarsus .... *dwibindus* Rao and Chalikwar 1971.
   Vertex strigosely rugose; female antenna 26 segmented terminal segment as long as wide; malar space 1.3 × the basal width of mandible; temple strigoso-reticulate; carapace strigoso-reticulately rugose; ovipositor as long as hind basitarsus .... *deogiri*, sp. nov.

ACKNOWLEDGEMENTS

The authors are grateful to Prof. S. D. KALYANKAR, Head, Department of Zoology, Marathwada University, Aurangabad for providing the laboratory facilities. First author (SMK) wishes to thank Principal K. H. SHITOLE, New Arts, Commerce and Science College, Ahmednagar for permitting to do this work at Marathwada University, Aurangabad.

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HEMOLYMPH ECDYSTEROIDS LEVEL AND OOCYTE DEVELOPMENT IN *TELEOGRYLLUS MITRATUS* (GRYLLIDAE : ORTHOPTERA)

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(*Received* 30 *January* 1993)

Ecdysteroid titres and oocyte development during the first oocyte cycle were studied in the cricket, *Teleogryllus mitratus*. 5.0 μg azadirachtin was administered to 48 h old adults to assess its effects on ecdysteroids and oocyte development. In controls, ecdysteroid level showed sharp increases from day 4 reaching the maximum level on day 7. Azadirachtin treatment significantly lowered the hormone titre. Development of the terminal oocyte was adversely affected by azadirachtin treatment.

(*Key words: Teleogryllus mitratus*, azadirachtin, ecdysterid, oocytes)

INTRODUCTION

Teleogryllus mitratus (Gryllidae: Orthoptera) is a semi-wild cricket attacking leafy vegetables causing considerable damage. Two other species, *T. commodus* and *Acheta domesticus* are very well studied especially their mating and oviposition behaviour, hormone titres and vitellogenesis (LOHER, 1979; LOHER *et al.*, 1983; SUGAWARA & LOHER 1986; SUGAWARA, 1986; MURTAUGH & DENLINGER, 1987; RENUCCI *et al.*, 1990). LOHER *et al.* (1983) have identified the juvenile hormone and estimated its fluctuations in relation to the ovarian maturation in *T. commodus.* No attempt has yet been made to estimate the ecdysteroids levels in the hemolymph of *Teleogryllus* and the role of this hormone in oocyte maturation. The present study was undertaken primarily to estimate the hemolymph ecdysteroids level during the reproductive cycle and to asses the rate of development of the oocytes. In addition to this, the influence of the phytochemical azadirachtin on ecdysteroids titre and oocyte maturation was also studied.

MATERIALS AND METHODS

Several generations of field collected crickets (*T. mitratus*) were reared in the laboratory on fresh cabbage and water. Last instar nymphs were separated from the culture and maintained individually for the adult moult. Newly ecdysed adults (within 1h) were collected and used for the experimental purposes at appropriate age.

Hemolymph was collected by cutting the hind leg. Ecdysteroids were extracted from the hemolymph with 70% methanol and assayed by radioimmunoassay as described earlier (STRAMBI *et al.*, 1984). Azadirachtin (from Prof. H. Rembold, Max-Planck Institute, Germany) was dissolved in 2% ethanol. 5 μg of azadirachtin was administered to 48 h old crickets by injection. Hemolymph of control and azadirachtin treated crickets was collected

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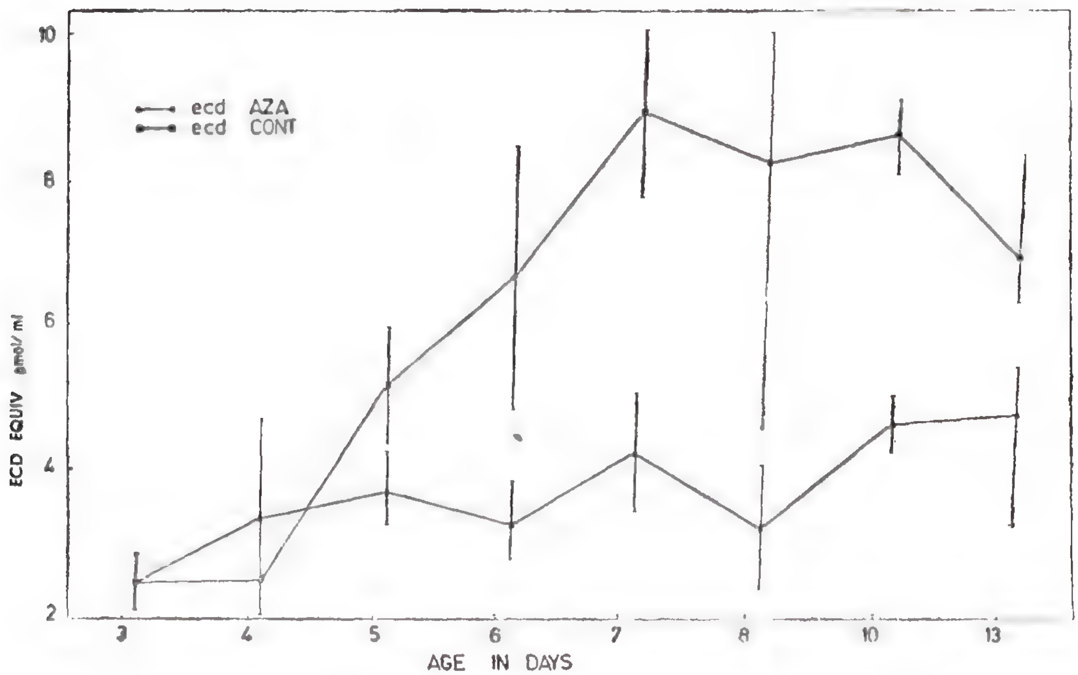

Fig. 1. Ecdysteroid titres in the hemolymph of control and experimental females of *T. mitratus*.

from insects of different age (3–13 days) for hormone titre assay. Both experimental and control insects were dissected and ovaries transferred into saline for measurements of the terminal (T), penultimate (T_1) and antepenultimate (T_2) oocytes.

RESULTS

Ecdysteroids:

Fig. 1 shows the data on the ecdysteroids level in the hemolymph of control and azadirachtin treated *T. mitratus*. In the control insects, ecdysteroids showed a sharp increase from day 4, reaching a peak on day 7. This level (9 pmol/ml) was maintained till day 10, thereafter a slow decline was noticed till day 13. In azadirachtin treated crickets, the hormone level was significantly low as compared to the control insects.

Oocyte development:

In *T. mitratus*, each ovary contained a maximum of 130 ovarioles. Measurements of the oocytes (T, T_1, and T_2) of control and experimental adults are presented in Fig. 2. The terminal oocyte showed a gradual increase in size, reaching the maximum on day 10. In the case of T_1 and T_2 the maximum size was measured on day 7, both showing the same pattern of growth. Treatment with azadirachtin showed significant reduction in the size of the terminal oocytes, while T_1 and T_2 did not show significant reduction in size.

DISCUSSION

In *T. mitratus*, the ecdysteroids level in the hemolymph showed a steady increase from day 4 of the adult life, reaching a peak on day 7. This level was maintained till day 10 and thereafter, a decline was noticed

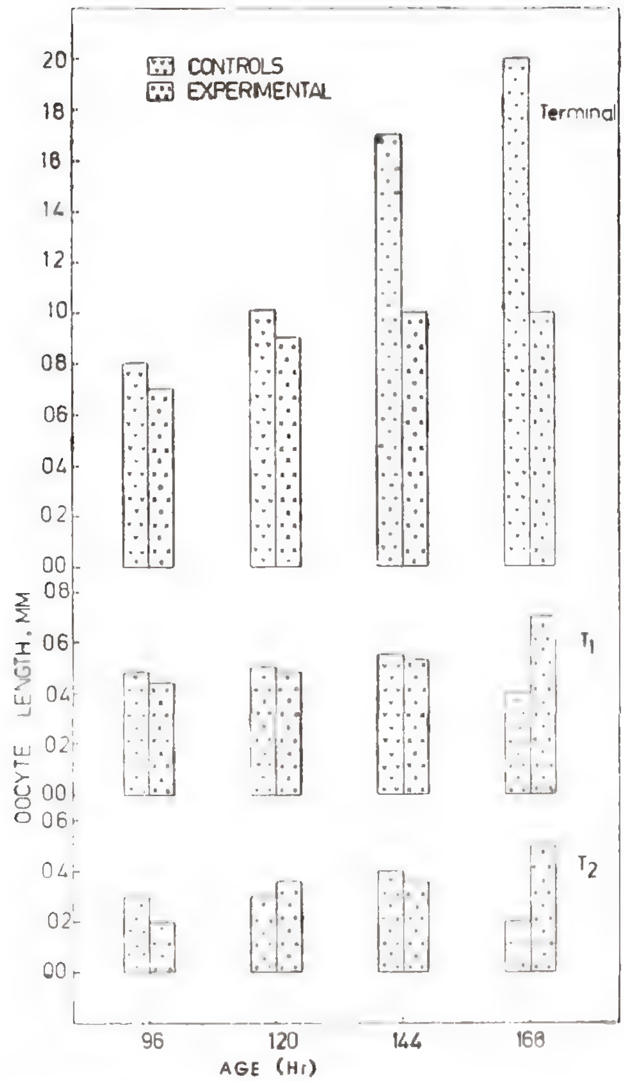

Fig. 2. Effect of azadirachtin on oocyte development in *T. mitratus*.

till the end of the first reproductive cycle. This observation is more or less similar to that of *A. domesticus* (unpublished observation). In *T. mitratus* treated with 5 μg azadirachtin on day 2 (48h) of the adult life, ecdysteroids level showed significant reduction from day 5 onwards. The present results are comparable to that of other insects (GARCIA *et al.*, 1990; MORDUE *et al.*, 1986; DORN *et al.*, 1986; SIEBER & REMBOLD., 1983; BARNBY & KLOCKE 1990), even though the earlier findings are from larval- or pupal stages of insect species studied. This adds further support to the view that azadirachtin affects the function of the prothoracic gland thereby reduce the level of ecdysteroids in the hemolymph. Though the development of the terminal vitellogenic

oocytes is adversely affected by azadirachtin treatment in *T. mitratus*, the growth of the penultimate and ante-penultimate ones are not affected.

ACKNOWLEDGEMENTS

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BEAUVERIA BASSIANA – A NEW INSECT PATHOGEN ON *ATTEVA FABRICIELLA* AND ITS COMPARATIVE EFFICACY WITH *PAECILOMYCES FARINOSUS*

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(*Received* 12 *August* 1990)

Beauveria bassiana **(Balsamo) Vuill is reported as a new insect pathogen of *Atteva fabriciella* in Kerala. Pathogenicity tests indicated that the pathogen is virulent in both the types of application methods, viz., direct and leaf application, but most effective in direct application with LC_{50} as 3.1×10^3 spores ml^{-1}. Comparative efficacy with another insect pathogen *Paecilomyces farinosus* isolted from *Eligma narcissus* indicated that *P. farinosus* is cross infective but *B. bassiana* is more virulent and gave promising results in direct application of spores.**

(*Keywords: Beauveria bassiana, Paecilomyces farinosus, Atteva fabriciella*)

INTRODUCTION

Shoot webber *Atteva fabriciella* Swed (Lepidoptera: Yponomeutidae) is one of the serious insect pests of *Ailanthus triphysa* (Dennst), a soft wood tree species recently raised as Forest plantations in various parts of Kerala. While studying the ecology and possible control measures of this insect (VARMA, 1986), a microbial pathogen *Pecilomyces farinosus* (Holm:Fr) Brown & G.Sm, isolated from another pest of *Ailanthus triphysa* viz., *Eligma narcissus* Roth. (Lepidoptera:Noctuidae) was checked for its cross infectivity to *A. fabriciella*. Other than this report, no detailed information is available on the microbial pathogens associated with *A. fabriciella*.

Instances of larval mortality was noticed in Kottappara *Ailanthus* plantation of Kothamanglam Forest Division of Kerala, during Aug-Dec. in 1986-1987. Infected larvae appeared white in colour due to profuse mycelial growth and dry powdery mass of spores were seen (Fig.1). The pathogen was isolated, mass multiplied on potato-dextrose agar (PDA) and identity confirmed as *Beauveria bassiana* (Balsamo) Vuill (IMI No. 310938). The pathogenicity of this fungus was later evaluated in the laboratory with a view to test its potential as a bio-control agent and also its comparative efficacy with *P. farinosus* (IMI No. 319937), isolated from *Eligma narcissus*, another insect pest of *A. triphysa*.

MATERIALS AND METHODS

Field collected larvae of third or fourth instars were used in the study. Spore suspension was prepared from a 7–10 day old culture and concentrations adjusted from $1 \times 10^2 - 10^5$ spores ml^{-1} using a Neubauer haemocytometer and sprayed either directly on to the larave (Expt. I) or on tender foliage and larvae were allowed to feed on the treated leaves (Expt. II). The experiments were replicated thrice with 10 larvae each and all the treated larvae

* KFRI Scientific Paper No. 209

were kept in plastic jars and incubated at $27 \pm 2°C$ and $> 75\%$ RH. Fresh feed was offered at 24 h interval. In controls, larvae and foliage were sprayed with sterile distilled water. Observations on development of symptoms and mortality were recorded at 24 h interval till $> 75\%$ mortality occurred in the experimental groups. The data on percentage mortality were subjected to probit analysis (FINNEY, 1977).


1a


1b

Fig. 1. *B. bassiana* affected *A. fabriciella* larvae. (a) Natural infection (b) Artificially inoculated.

RESULTS AND DISCUSSION

In direct application of spores (Expt. 1; Fig. 1) of *B. bassiana* ca. 80% mortality was observed in highest concentration after 72 h (Table 1). However, profuse mycelial growth was seen only by 96 h and the whole larvae on further incubation became a ball of spore mass by 120 h. The mortality rate came down with reduction in spore concentration. In direct treatment involving *P. farinosus* only 60% of the treated larvae were infected due to fungal infection in the highest concentration ie., 1×10^5 spores ml^{-1} and there was only 10% death at 1×10^2 spores ml^{-1} the lowest concentration used. The LC_{50} value was 3.1×10^3 spores ml for *B. bassiana* while it was 3.3×10 spores ml^{-1} for *P. farinosus* indicating the higher virulent nature of *B. bassiana*. Direct application method involving both the pathogens was significantly different from one another (t value = 2.976) indicating that *B. bassiana* was more virulent than *P. farinosus* (Figs. 2a, 2b). In both treatments as well as in control uninfected larvae pupated normally and adults emerged as usual.

In the second set of experiments, where larvae were exposed to *B. bassiana* treated leaves (Expt. II) only 40% of larvae were killed at the highest concentration, followed by 33.3% and 26.6% mortality at spore concentrations of 10^4 and 10^3 spores ml^{-1} respectively. Mortality ranged from 40 to 20% in larvae fed on *P. farinosus* treated leaves. In the lowest concentration tested the mortality percentage was only 10% for both the pathogens. The LC_{50} values were 3.8×10^5 spores ml^{-1} for *B. bassiana* and 6.0×10^5 spores ml^{-1} for *P. farinosus*.

TABLE. 1. Comparative efficacy of *B. bassiana* with *P. farinosus* against *A. fabriciella*.

Pathogen *		*B. bassiana*				*P. farinosus*			
		Concentration (Spores ml^{-1})							
		1×10^5	1×10^4	1×10^3	1×10^2	1×10^5	1×10^4	1×10^3	1×10^2
Application method		Percent mortality of insects at 96 hrs.							
Direct		80.0	53.3	40.0	26.6	60.0	40.0	23.0	10.0
LC_{50}		3.1×10^3	spores ml^{-1}*			3.3×10^4	spores ml^{-1}*		
Fiducial limit									
	Upper	11.6×10^3	spores ml^{-1}			25.1×10^4	spores ml^{-1}		
	Lower	8.3×10^2	spores ml^{-1}			10.5×103	spores ml^{-1}		
Indirect		40.0	233.3	26.6	10.0	40.0	26.6	20.0	10.0
LC_{50}		3.8×10^5	spores ml^{-1}	NS		6.0×10^{-5}	spores ml^{-1}	NS	
Fiducial limit									
	Upper	16.2×10^6	spores ml^{-1}			25.8×10^6	spores ml^{-1}		
	Lower	0.0×10^3	spores ml^{-1}			1.4×10^4	spores ml^{-1}		

* = Significant at $p = 0.05$ NS = Non significant.

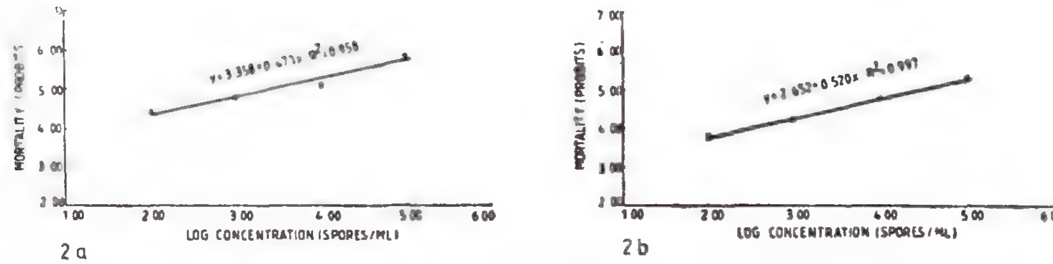

Fig. 2. Concentration - mortality curve of *A. fabriciella*, in direct application method. (a) involving *B. bassiana* (b) involving *P. farinosus.*

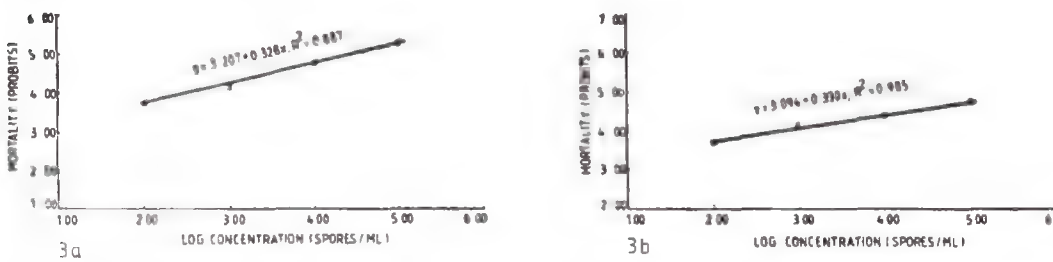

Fig. 3. Concetration - mortality curve of *A. fabriciella* in indirect application method. (a) involving *B. bassiana* (b) involving *P. farinosus.*

Indirect application method involving both the pathogens were not significant (t value 0.389 NS) (Fig. 3a, b). Here also uninfected larvae pupated and normal adults emerged.

Results of the present study confirmed that *P. farinosus* isolated from *E. narcissus* is cross infective to *A. fabriciella,* but when compared to the native pathogen *B. bassiana* it was found that *B. bassiana* is more virulent than *P. farinosus* and gave most effective results in direct application of spores. The reason for the lower virulence of both the pathogens in indirect application method may be due to the feeding behaviour of this insect, as they form a web around very tender foliage, and the chances of enough number of spores coming into contact with the insect may be low.

Some of the forest insects reported to be affected by *B. bassina* from India are teak skeletoniser *Eutectona machaeralis* from Karnataka (PATIL & THONTADARYA, 1981) and teak sapling borer *Sahydrassus malabaricus* from Kerala (MOHAMED ALI & MATHEW, 1989). *B. bassiana* had been reported from *Eligma narcissus* (CHATTERJEE & SENSARMA, 1968) but its pathogenicity was not tested.

P. farinosus is an ubiquitous insect parasite equally common in temperate and tropical zones with an unlimited host range (LEATHERDALE, 1970), and considered as a potential biocontrol agent. Biological control experiments using this fungus against Colorado beetle *Leptinotarsa decemlineata* (BAJAN *et al.*, 1982), elm bark beetle *Scolytus scolytus* (DOBERSKI, 1981) and hairy caterpillar *Eligma narcissus* (VARMA,1986) were successfully carried out.

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BRIEF COMMUNICATION

SOME ASPECTS OF BIOLOGY OF *LONGITARSUS NIGRIPENNIS* MOTS. (COLEOPTERA : CHRYSOMELIDAE), A SERIOUS PEST ON BLACK PEPPER, *PIPER NIGRUM* L.

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Some aspects of biology of 'pollu' beetle (*Longitarsus nigripennis* Mots.) on black pepper (*Piper nigrum* L.) was studied in the laboratory at ambient conditions (29 ± 4°C and 70-85% RH). Mating lasted for 4-8 hours. Eggs were laid singly or in groups of 2-3, mostly on tender berries. Incubation period of eggs varied from 5-8 days. Larval stages comprising of three instars were completed in 22-32 days. Pupal period lasted for 6-7 days. Morphometrics of various stages are provided.

(*Key words:* 'Pollu'beetle, *Longitarsus nigripennis* Mots., black pepper, *Piper nigrum* L., pest biology)

The flea beetle or 'pollu' beetle, *Longitarsus nigripennis* Mots. (Chrysomelidae: Coleoptera) is a major pest of black pepper (*Piper nigrum* L.) in India, causing considerable damage to berries and leaves (PILLAI, 1978). The incidence of the pest is reported to be high (20–30 per cent) in the plains of Malabar area and low (5–10 per cent) in Wynad and Travancore areas of Kerala (ANONYMOUS, 1954). Aspects of life history of the pest were reported by AYYAR (1920), AYYAR *et al.* (1921), RAO & RAMASWAMIAH (1927), PREMKUMAR (1980), DEVASAHAYAM *et al.* (1988) and PREMKUMAR & DEVASAHAYAM (1989). An attempt is made in this paper to provide additional information on the biology of *L. nigripennis* Mots.

Bush pepper, *Piper nigrum* L. (Piperaceae) (Panniyur–1, half to one year old) was raised in earthen pots of 25 cm diameter filled with mixture of sand, soil and dried cow dung. The pots were maintained inside on insect proof cage of 2 × 1.5 × 1.5 m size under shade at a temperature of 29 ± 4° C and 70–85% RH. Adult beetles were collected from the field from Central Plantation Crops Research Institute, Palode and reared on bush pepper. A pair of adult beetle was released on each plant which was covered with nylon net to prevent its escape and to study mating and oviposition behaviour.

Newly hatched larvae were allowed to feed on tender berries. The third instar larvae were transferred to glass vials (20 × 100 mm) half filled with moist sand for pupation. The number of larval instars were distinguished based on head capsule widths. Larval and pupal periods were recorded. Morphometric measurements of different stages were done with an ocular micrometer under a stereomicroscope. Results are given in Table 1.

Multiple mating was observed throughout the adult life span; mating lasts for 4–8 hours. Mating generally takes place during day time, but those which start mating at dusk continued to be in mating position during night also. The male positions itself on the posterior dorsum of the female at about an angle of 45° with the first pair

TABLE 1. Duration of life history and morphometrics of *Longitarsus nigripennis* Mots. on black pepper.

Stage	Number	Mean duration (days)	Mean length (mm)	Mean width (mm)
Egg	36	6 – 5 ± 1 (5 – 8)*	0.73 ± 0.02 (0.70 – 0.80)*	0.30 ± 0.01 (0.29 – 0.34)*
I instar	31	6 ± 1 (5 – 7)	1.35 ± 0.05 (1.27 – 1.40)	0.22 ± 0.03 (0.20 – 0.27)
II instar	28	9 ± 1 (8 – 10)	3.5 ± 0.6 (3.4 – 3.8)	0.43 ± 0.03 (0.38 – 0.46)
III instar	34	13 ± 1.3 (12 – 15)	5.5 ± 0.03 (5.2 – 5.8)	0.76 ± 0.02 (0.74 – 0.78)
Pupa	25	6 ± 0.6 (6 – 7)	3 ± 0.03 (2.7 – 3.3)	1.30 ± 0.05 (1.26 – 1.34)
Adult	41	—	2.5 ± 0.02 (2.3 – 2.6)	1.3 ± 0.02 (1.2 – 1.45)

* Range

of legs near the female's elytra; the second pair of legs clasp the female about midway on the lateral margin of the elytra and the third pair of legs hold the terminal segments of female's abdomen. The male bends the tip of its abdomen down, extends and inserts the aedeagus into the female's vagina. The pair shows intermittant movement in the mated position with the male above the female during the copulation period.

Eggs are laid singly or in groups of 2–3 in each hole made by scraping of tissues on the growing bud, leaf petiole, terminal nodes, tender spikes and young berries. The eggs are covered over by faecal matter mixed with a gummy exudation after deposition.

Both adults and larvae of *L. nigripennis* damage various parts of *P. nigrum* as reported by earlier workers. The egg, larval and pupal periods last for 5–8, 22–32 and 6–7 days respectively. RAO & RAMASWAMIAH (1927) and PREMKUMAR & DEVASAHAYAM (1989) also make similar observations. It has three larval instars; a similar finding was reported by IRESON *et al.* (1991) in case of *L. flavicornis*.

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BRIEF COMMUNICATION

COMPARISON OF A DRY AND A WATER TRAP FOR MONITORING POTATO TUBER MOTH *PHTHORIMAEA OPERCULELLA* ZELLER

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Trapping efficiency of two types of sex pheromone baited traps (dry and water) was evaluated for monitoring *Phthorimaea operculella* Zeller population in potato fields. Although the mean number of males caught per trap per week by the dry trap (89.2) was more than the water trap (76.9), the differece was not statistically significant. Field observations suggested and laboratory studies confirmed that water level was a critical factor affecting trapping efficiency of the water trap.

(*Key words*: Potato tuber moth, *Phthorimaea operculella*, water trap, dry funnel trap, water level)

Potato tuber moth *Phthorimaea operculella* Zeller is a major pest of potatoes in field as well as in stores. Two types of traps, water (CHANDLA et al., 1987; RAJ, 1988) and dry funnel (RAMAN, 1984; LAL, 1989) are used for monitoring its populations in the fields. For a programme of evaluation of pheromones, indigenously developed in our laboratory, a choice had to be made between the two types of traps. A trial was therefore undertaken in potato fields near Pune in rabi season of 1989–1990 in which a water trap and a dry funnel trap were evaluated for their trapping efficiency.

Four traps of each type: water as per RAJ (1988) and modified dry funnel as per RAMAN (1984), but with 8.5 cm dia funnel)—were kept randomly in two parallel rows in potato fields, the distance between rows being 50 m and traps being 30 m. Each trap was baited with a rubber septum, which was impregnated with 1 mg of the sex pheromone (diene and triene in a 2:3 ratio). The traps were placed 40 cm above ground level (RAMAN, 1984) and were moved one place each every week after trap catch observation. The trap catch values were transformed to log X + 1 before statistical analysis [(t) test].

The seasonal mean of the weekly trap catches (9 weeks) for the modified dry funnel trap (89.2 males) was more than the water trap (76.9 males), but the difference was not statistically singificant (Table 1 A; 't' = 1.65). However, the variation in weekly trap catches was larger in case of the water trap than the dry trap (range: water trap, 50.5 to 117.3; dry trap, 76.0–117.1. Variance (transformed) : water trap, 0.039; dry trap, 0.025. Further, the only statistically significant difference (t = 5.52; P = 0.05) in trap catch during a week (1st week) showed the water trap to be catching less moths than the dry trap. Although efforts were always made to maintain the water level in the trap at 2 cm from the pheromone bait, doubts arose regarding the role of water level *vis a vis* trap catch. In the absence of availability of a systematic study in literature on this aspect in case of potato tuber moth, an experiment was taken up in laboratory in which the distance

TABLE 1. Trap catch by water and dry trap.

(*A*) *FIELD STUDY* *Mean males per trap*			(*B*) *LABORATORY STUDY* *Number of males trapped* (*out of* 30)		
Week	Water trap	dry trap	Distance between water and bait (cm)	water trap	dry trap
I	50.5	95.0[a]	2.0	25	12
II	53.0	76.9	3.5	15	10
III	59.7	76.0	5.0	9	16
IV	100.5	116.2	6.5	8	21
V	86.2	81.2	8.0	7	10
VI	117.3	76.3	9.5	4	20
VII	94.8	94.0	11.0	1	20
VIII	67.1	82.2			
IX	98.2	117.1			
Season Meann	76.9	89.2[b]			

(a – significant difference; b difference not significant; 't' tst)

between water level and pheromone bait in the water trap was increased at 1.5 cm interval from 2 cm to 11 cm. Everyday, thirty, 24 to 48 hours old males were released in a nylon mesh cage (2 m × 1 × 1 m height 20 mesh) and trap catch was recorded on the next day. Observations on dry trap catches were also recorded separately. During the experiment, the dry trap caught a mean of 15.5 males (range 10–21) compared to 9.8 by water trap (range 1 – 25). (Table 1B). While the daily catch by the dry trap varied randomly, in case of water trap, a significant and negative correlation ('r' = –0.9161; $P = 0.01$) between water level – pheromone bait-distance and trap catch was evident. The laboratory study demonstrated a total dependance of water trap on water level – a factor likely to be subject to weather conditions under field situations and indicated that a dry funnel trap would be more suitable for monitoring field populations of potato tuber moth.

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BRIEF COMMUNICATION

SEXUAL DIMORPHISM AND INTRA-SEX VARIATIONS IN THE ELEPHANT DUNG-BEETLE *HELIOCOPRIS DOMINUS* (COPRINAE: SCARABAEIDAE)

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Sexual dimorphism and intra-sex variations (female dimorphism and male polymorphism) are well-marked in *Heliocopris dominus*. Based on morphological criteria such as the size and shape of individuals, shape of clypeus and pronotum and the number, position and presence or absence of horns on the clypeus and pronotum, individuals of this species could be differentiated into females of Phases I & II and into males of Phases I, II & III including an Inter-Phase between the males of Phases I & II. It was found that the larger the size of the individuals was, the higer was the grade of development of the horns and other secondary sexual characters, and *vice versa*.

(*Key words*: *Heliocopris dominus*, sexual dimorphism, female dimorphism, male polymorphism)

The vast group of dung-beetles comprising the subfamily *Coprinae* (*Scarabaeidae* : *Coleoptera*) are interesting on account of the great abundance and diversity of their horns, spines and similar outgrowths which generally serve to distinguish the male sex. Such secondary sexual characters are highly developed in the giant-sized dung-beetles of the genus *Heliocopris*. In the elephant dung-beetle *Heliocopris dominus* Bates such characters have found their maximum expression. ARROW (1931) gave a short account of the phenomena of sexual dimorphism and male variations in this species. The present paper is based on data collected by the author during the course of a three year project work on the biology of *H. dominus*.

The distribution of *H. dominus* (which depends exclusively on the dung of wild elephants for feeding and breeding) coincides with the habitats of wild elephants and therefore the specimens for the study were collected from the elephant habitats in the Reserved Forests of the Nilambur South Division, coming under the Karulai Range. This study is based on 21 female and 22 male specimens. The various female and male Phases were differentiated on the basis of the size and shape of body, the shape of the clypeus and pronotum, and on the number, position & presenec or absence of horns on the clypeus and pronotum.

Sexual dimorphism (Figs. 1 & 3). The *large female* (*Phase I*) are 57–63 mm long, 35–37 mm wide at base of pronotum and weigh from 9–10 g. The *large 2- horned males* (*Phase I*) are generally longer (63-66 mm) and larger and wider-bodied (38–39 mm) than the females of Phase I. These males weigh from 14–15 g. The colouration in both the sexes of these forms is generally dark brownish-black.

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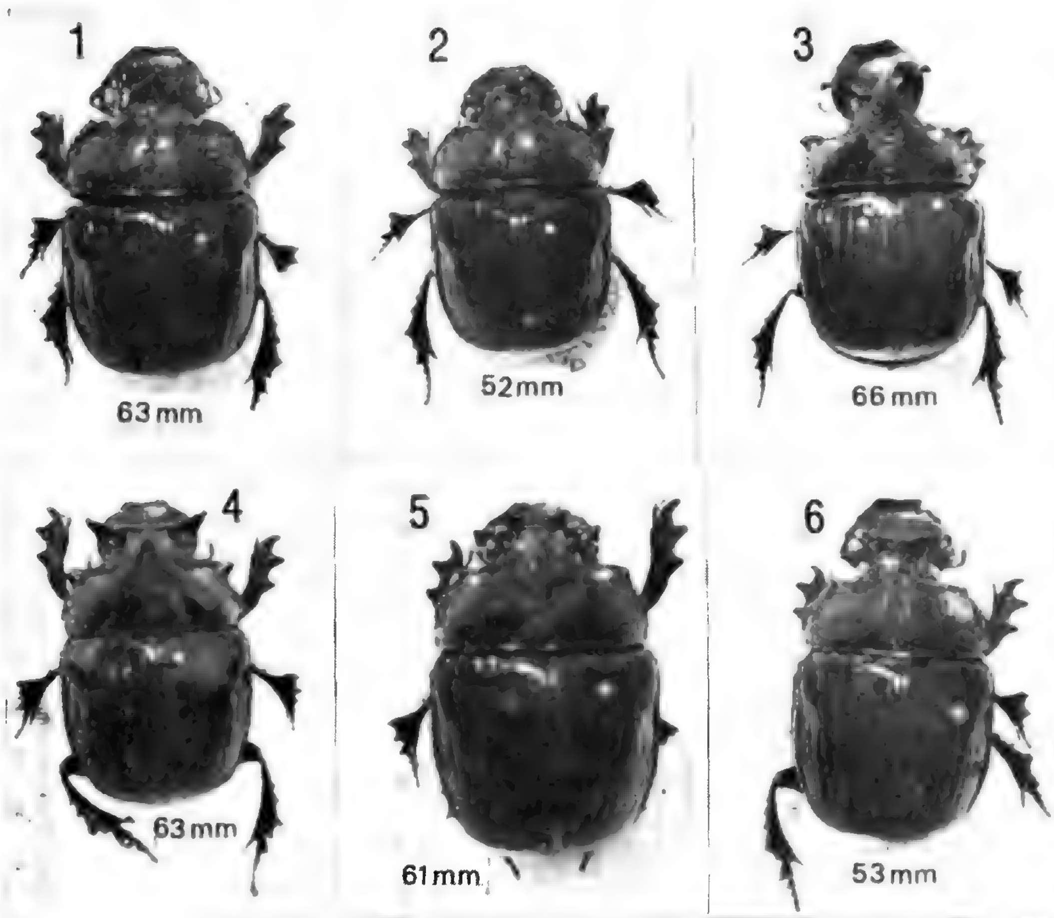

Figure 1: Large female (Phase I); Figure 2: Small female (Phase II); Figure 3: Large 2-horned male (Phase I); Figure 4: Inter-Phase between Phase I & Phase II males; Figure 5: Medium-sized 4-horned male (Phase II; Figure 6: Minimum-sized male (Phase III). On each Figure is indicated the length (mm) of the specimen photographed, to present the comparative lengths of the various Phases.

Female dimorphism (Figs. 1 & 2). In the *large females* (*Phase I*) the clypeus has a cephalic carina acuminate in the middle, forming a triangular horn. At the base of this horn on either side and a little behind it is a smaller horn. Almost the entire lateral margins of the pronotum on either side antero-laterally are denticulate, these denticles becoming larger from behind forwards and terminating anteriorly in short inconspicuous lobes disposed almost at right angles to the long axis of the body. The anterior almost vertical part of the pronotum is divided from the posterior part by a prominent transverse carina which is more prominent in middle than at the sides. In body shape these large females greatly resemble the small females Phase II and the small minimum-sized males Phase III.

The *small females* (*Phase II*) are much smaller (length 48 – 52 mm) in size than the females of Phase I described above. The

clypeus has the cephalic carina with a very small median horn, on either side of which is present a horn of about the same size as the median horn. The lateral margins of the pronotum on either side are similar to those of female Phase I. The anterior vertical part of the pronotum and the transverse carina delimiting it from its posterior part are as in the large females Phase I and as in the minimum-sized males Phase III (Fig. 6). On the whole there is greater resemblance in the body and of the prothorax of the small females Phase II and of the minimum-sized males Phase III.

Male polymorphism (Figs 3, 4, 5 and 6): The *large 2 horned males (Phase I)* are the largest of the males. The clypeus is demarcated from the forehead by a sharp but slightly elevated carina lying a little backwards. A pair of prominent, erect, slightly divergent horns arise from the lateral margins of the head at the outer extremities of the carina, each horn a little flattened from before backwards and obliquely truncated or bilobed at the summit (Fig. 3). The forehead is long; the lateral margins of the ocular lobes are straight and slightly diverging from the eyes forwards to the base of the lateral horns. The anterior one-third of the lateral margins of the pronotum on either side are highly sclerotised and produced into well developed ear-like lobes, their anterior tip forming a small hook and the posterior tip forming a well defined recurrent hook directed sideways. The anterior vertical part of the pronotum is demarcated from the posterior part by a distinct transverse carina which is produced in the middle forming a sharp-pointed, slightly upturned, triangular horn projecting about 10 mm beyond the pronotal carina.

The *medium-sized 4-horned males (Phase II)* are from 58–61 mm in length. Their lateral (outer) horns on the head at the extremities of tne cephalic carina have undergone a reduction in size. On the other hand, the transverse carina between these lateral horns is strongly elevated and produced into 2 sharp horns, one on either side of the median line. Thus the head bears 4 somewhat equal-sized horns. The anterior ear-like lobes of the lateral margins of the pronotum are less pronounced than in the large 2–horned males (Phase I). The transverse pronotal carina is prominent but the median pronotal prolongation is reduced forming an obtuse-angled horn projecting hardly about 3 mm beyond the pronotal carina. It is interesting to note that an *Inter-Phase* (Fig. 4) between Phase I and Phase II males is often met with, showing characters intermediate between these 2 male Phases.

The *minimum-sized males (Phse III)* are the smallest (48 – 53 mm in length) of the males. In these the lateral (outer) horns of the head have disappeared and the elevated cephalic carina presents 2 sharp-angled horns which are smaller than these same structures in Phase II males. The pronotal horn is totally absent, the transverse pronotal carina being little more prominent in the middle than at the sides. The outer margins of the pronotum terminate anteriorly in inconspicuous lobes lying almost at right angles to the long axis of the body.

The study of sexual dimorphism and intra-sex variations (unisexual variations & polymorphism) in several groups of insects has shown that the degree of development of the horns and other secondary sexual characters is closely correlated with the size of the individuals showing them, or that these characters follow the principle of *allometry* (Emery, 1901; Grandi, 1930; Arrow, 1931; Kingston & Coe, 1977). Associated with this correlation between size and armature is the observation that outgrowths peculiar to the male show a

tendency to appear in the largest forms of such insects, and rarely, if ever, are found in the smallest forms. It was also observed that in case a reduction in the size of the armature occurs in a particular position, a compensatory outgrowth may appear in some other position. For example, in the medium-sized males (Phase II) of *H. dominus* the outer horns are reduced in size while the transverse carina between the lateral horns becomes strongly elevated and produced into two short and sharp horns, giving rise to the 4-horned individuals of Phase II (Fig. 5).

Sexual dimorphism, female dimorphism and male polymorphism are well-marked in insects living in highly specialised environments. Good examples are certain chalcidoid fig-wasps (JOSEPH, 1984) and the scarabaeoid bettles of the family *Lucanidae* and the sun-families *Dynastinae* and *Coprinae* (ARROW, 1931). While sexual dimorphism might have arisen as adaptations in response to the different roles the wo sexes have to play in the specialised environment, female dimorphism and male polymorphism can be attributed to arise on account of trophic factors like adequacy or inadequacy of food during development (JOSEPH, 1957).

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BRIEF COMMUNICATION

STUDIES ON EVALUATION OF HYBRIDS BY BREEDING INDEX IN *BOMBYX MORI* (L)

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(*Received* 26 *December* 1991)

Eight new bivoltine hybrids (F_1) were compared for their relative and heterobeltiotic responses in silk productivity. Hybrid KPG-B × P_5 and its reciprocal have shown higher values in silk productivity along with high degree of relative heterosis and heterobeltiosis.

(*Key words: Bombyx mori*, silk productivity, heterosis)

The exploitation of superior hybrids for the production of silk has unequivocally been accepted to be the only way of improving sericulture industry in any country (SENGUPTA et al., 1971; TAYADE, 1987).

Relatively recently, silk productivity expressed in cg of shell weight per day of fifth larval duration have been reported as a breeding index to evaluate silkworm breeds and their single, three way and double hybrids (UDUPA & GOWDA, 1988; SINGH et al., 1990). In the present study an attempt has been made to evaluate eight new hybrids of bivoltine silkworm, *Bombyx mori* (L) for their relative and heterobeltiotic responses in silk productivity with the object of selecting out the most prospective ones for their inclusion in the competitive productive testing during commercial rearing seasons.

Four promising breeds of bivoltine silkworm *Bombyx mori* namely, 'P 5' and 'NB_{18}' (dumbell shaped cocoons) and 'KPG–B' and 'NB_7' (oval cocoons) having adequate genetic diversity were crossed in all possible combinations avoiding hybridization of breeds with similar cocoon characters. Hence eight hybrids formed the experimental material for the present study. Silk productivity per day of fifth larval duration of four pure breeds and eight hybrids during recommended commercial rearing seasons, (average of three seasons: February–March August–September and October–November were compared to mid-parental (relative heterosis) and better parental (heterobeltiosis) values.

All the crosses have shown hybrid vigour when compared to mid-parental or better parental values (Table 1). The higher value in silk productivity (5.05 cg) was recorded in 'KPG'–'B × P_5' hybrid which have also shown higher degree of relative heterosis (32.89%) and heterobeltiosis (32.20%) followed by its reciprocal (P_2 × KPG–B) with silk productivity value of 4.75 cg and 25.00% and 24.35% heterosis respectively by the two methods. Lower value in productivity (4.20%cg) was recorded in 'NB_{18}' × 'NB_7' hybrid which have also shown lower degree of relative heterosis (4.75%) as well as heterobeltiosis (1.21%). The magnitude of silk productivity which is the combined effect of effective rate of rearing and cocoon-shell weight is being reflected into the heterosis. As such the hybrids with higher values in silk productivity have shown the higher degree of heterosis as was also

TABLE 1. Silk productivity and heterosis in some bivoltine hybrids (F_1) of silkworm, *Bombyx mori* (L).

Breeds/Hybrids	Silk productivity/day (cg)			Heterosis %	
	Breeds/hybrids value	Mid parent value	Better parent value	Relative heterosis	Heterobeltiosis
P_5	3.82				
KPG–B	3.77				
NB_7	3.87				
NB_{18}	4.15				
KBG–B × P_5	5.05	3.80	3.82	32.89	32.20
P_5 × KPG–B	4.75	3.80	3.82	25.00	24.35
NB_7 × NB_{18}	4.70	4.01	4.15	17.21	13.25
NB_{18} × NB_7	4.20	4.01	4.15	4.74	1.21
P_5 × NB_7	4.62	3.85	3.87	20.00	19.38
NB_7 × P_5	4.22	3.85	3.87	9.61	9.04
KPG–B × NB_{18}	4.60	3.96	4.15	16.16	10.84
NB_{18} × KPG–B	4.37	3.96	4.15	10.35	5.30

reported earlier (UDUPA & GOWDA, 1988; SINGH et al., 1990.)

From the present study, it could be concluded that 'KPG–B × P' hybrid and its reciprocal having shown higher values in silk productivity combined with high degree of heterosis may be exploited during commercial rearing seasons after further evaluation on multilocational trails.

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Entomon 1994 Vol. 19 No. 3 & 4 pp. 171 to 173

BRIEF COMMUNICATION

DESCRIPTION OF HITHERTO UNKNOWN MORPHS OF *CERVAPHIS QUERCUS* TAKAHASHI (HOMOPTERA: APHIDIDAE) FROM NORTH-EAST INDIA

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(*Received* 27 *October* 1991)

Alate oviparous female and alate male of *Cervaphis quercus* have been described for the first time.

(*Key words* : sexual morphs, aphids)

Genus *Cervaphis* (Greenideinae : Cervaphidini) is known by 4 species (Hille Ris Lambers, 1956) distributed in India, Indonesia, Japan, Korea, Malaysia, The Philippines, Thailand and Vietnam. None of the species under the genus was recorded by any sexual morph (Ghosh, 1987). Recently 4 alate oviparous females of *C. quercus* were found (BKA) in the collections of the British Museum, London. Further, some materials of alate oviparous female and alate male were collected in Manipur (KS). This paper describes both the sexual morphs of the species for the first time.

Alate oviparous female (Fig. 1):

Body pale brown 1.47 – 2.05 mm long and 0.60–0.86 mm wide in the middle of abdomen. Head brown, dorsum smooth, frontal process recognisable as short acute horns with 3–4 stout hairs; dorsal hairs long with fine apices and 6 on each side. Antennae 5-segmented, 0.67–0.98 mm long, flagellum imbricated, bearing 5–6 round secondary rhinaria on segment III (Fig.2), processus terminalis 1.05–0.22 × as long as base of the last antennal segment; flagellar hairs short, with blunt, longest one 0.01–0.02 mm long. Ultimate rostral segment 0.16–0.20 mm long, bearing 4–5 minute accessory hairs, 2.0–2.42 × as long as second segment of hind tarsus. Dorsum of abdomen smooth, with spino-pleural light brown patch on tergites 3–5, other segments with a few broken light brown sclerites on spino-pleural or marginal areas; marginal low tubercles distinguishable on ante-siphuncular tergites, each bearing many tiny hairs; dorsal hairs very small, on normal sockets with acute or blunt apices and distributed irregularly. Siphunculi brown, 0.68–0.82 mm long, 0.41–0.47 × as long as body, with spinular imbrications, bearing 8–10 hairs along its length and an apical ring of 4–5 hairs. Caudal stylus just visible. Subanal plate lined with numerous fine hairs. Female genitalia well developed, otherwise as in alate viviparous female.

Alate male (Fig. 3):

Body 1.40 mm long and 0.57 mm wide in the middle of abdomen. Head brown. Antennae 5-segmented, 0.84 mm long and 0.60 × as long as the body; flagellum gradually more strongly imbricated apical, segment III (Fig. 4) with 4 round accessory rhinaria, primary rhinaria non-ciliated,

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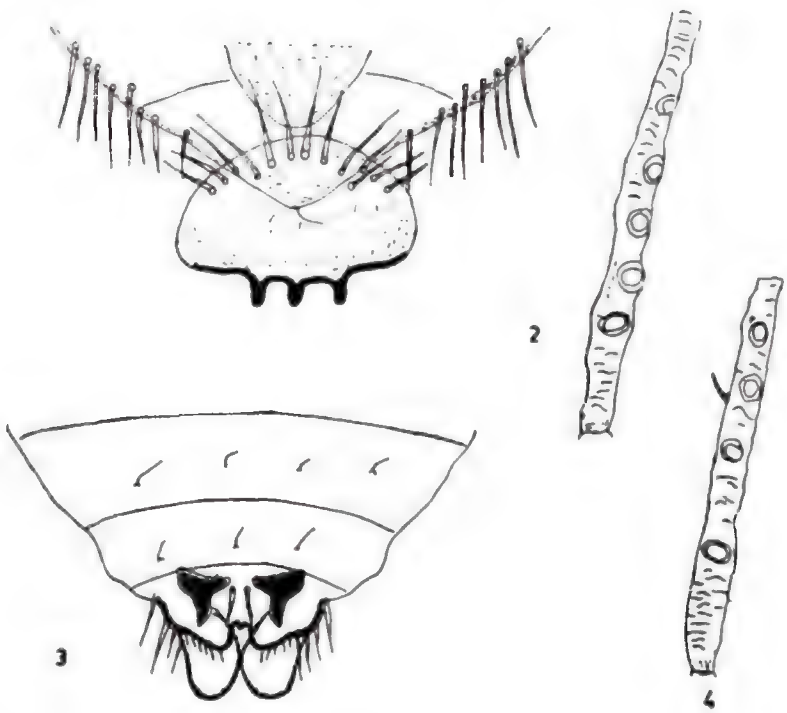

Figs. 1 and 2 *Cervaphis quercus* Takahashi alate oviparous female. 1. genitalia; 2. antennal segment III showing secondary rhinaria. Figs. 3 and 4 *C. quercus* Takahshi alate male. 3. genitalia; 4. antennal segment III showing secondary rhinaria.

processus terminalis 1.22× as long as base of the last antennal segment, flagellar hairs short, with acute apices, longest one on segment III 0.01 mm long. Dorsum of abdomen sparsely spinulose, densely so on the venter; transverse sclerotic bands present on tergites II, III and IV but broken marginopleurally or narrow spino-pleural bands present on other tergites; marginal processes absent, these reduced to low tubercles on anterior tergites, placed on wide sclerotic bases and studded with many small hairs; dorsal hairs short, tergites 1–5 with a set of bunch of 3–5 hairs placed one each in spinal and pleural areas besides the individual hairs; tergite 6 with only a pair of pleural and tergite 7 with a pair of spinal bunch of hairs; longest hair on anterior tergites 0.01 mm long. Siphunculi brown, broad at base and rest thin, with spinular imbrications, bearing 8–10 hairs along its length and an apical ring of 4–5 hairs. Male genitalia well developed. Femora and tibiae pale brown at base and brown at apex. Other characters as in alate oviparous female.

Materials examined :

26 apterous viviparous females, 5 alate viviparous females, 4 alate oviparous females and 2 alatoid nymphs from an unidentified host, Morrangknag, Shillong, ? viii. 1965, Coll. CIBC, India; 15 apterous viviparous females, 4 alate oviparous females, 1 alate male and many nymphs from *Quercus*

serrata (Fagaceae), Mantripukhri, Manipur, 24.v.1991, Coll. K. Shantibala.

ACKNOWLEDGEMENTS

Thanks are due to the Commonwealth Scholarship Commission, U.K. for granting financial assistance to BKA to examine the part collections of sexual morphs of this study and to Dr. R. L. BLACKMAN, Department of Entomology, British Museum (Natural History), London for permission to study the material. One of authors (KS) is also grateful to the Director, Science, Technology & Environment, Govt. of Manipur for granting Research Fellowship to carry out the work.

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BRIEF COMMUNICATION

NEW RECORD OF FUNGAL PATHOGEN, *APHANOCLADIUM ALBUM* (PREUSS) GAMS ISOLATED FROM MULBERRY SILKWORM, *BOMBYX MORI* L. FROM INDIA

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(*Received* 12 *April* 1991)

Infection of the silkworm *Bombyx mori* by a fungal pathogen *Aphanocladium album* (Preuss) Gams is reported here for the first time.

(*Key Words:* Fungal pathogen, *Aphanocladium album, Bombyx mori*)

During studies on fungal diseases of silkworms, authors collected corpses showing slightly pink color. These later turned to creamy white color. A microscopic study revealed the presence of mycelia and fungal spores. The pathogens were then isolated from the body surface of dead larvae with sterile forceps and inoculated into a Saboured Dextrose Agar medium containing yeast extract (SDA + Y) and cultured following the method of Thomas (1974). The cultures were incubated at 26 ± 2° C and 80 ± 5 % relative humidity. Initially the culture colonies were white in colour and after 72 hours turned to creamy. The fungus was identified as *Aphanocladium album* (Preuss) Gams by C.A.B. International Mycological Institute, United Kingdom. The characters of the isolated fungus are similar to earlier descriptions for the species (Gam, 1971; Carmichael *et al.*, 1980). Hyphae are creepy, highly branched with slightly noticeable septa. The hyphal length is 70 ± 15 μm and breadth is 1.5 ± 0.6 μm. Conidiophores arise as short lateral branches. Phialids are aseptate, found in whorls or solitary. Conidia are ovoid with apiculate basis, hyaline and measure 1.2 ± 0.4 μm breadth; 1.6 ± 0.7 μm in length. The disease development in silkworms was further studied by infecting silkworms with conidial spores of *A. album*. Three ml of pathogen suspension containing 10^7 spores/ml harvested from fresh cultures were sprayed using glass atomiser over 50 bivoltine III instar silkworms. Silkworms were reared under temperature 27 ± 2° C and high

Fig. 1. Dead silkworms showing black spots on the surface of body due to attack of *A. album*.

humidity (80 $\pm$ 5%) conditions. After 5–6 days, the infected larvae died. The dead larvae showed slightly brown/pink colour and were hard to touch. Black spots were noticed on the body surface of the silkworms where fungus entered into the body (Fig. 1). Again after 4–5 days, the corpses turned to creamy white colour. The rate of mortality of silkworms due to fungal infection was 12%. Further studies on pathogen dosage effects on different ages of silkworms is in progress.

ACKNOWLEDGEMENTS

The authors are thankful to Dr. M.A.J. WILLIAMS, C.A.B. International Mycological Institute, Kew, Surrey, United Kingdom for identifying the species.

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BRIEF COMMUNICATION

STETHOCONUS PRAEFECTUS (DISTANT), A PREDATOR OF *TELEONEMIA SCRUPULOSA* STAL. IN BANGALORE, INDIA

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(*Received* 29 *July* 1992)

The predatory bug, *Stethoconus praefectus* (Distant) was found to feed on the nymphs and adults of the lantana bug, *Teleonemia scrupulosa* Stal. This is the first record of any predator attacking *T. scrupulosa* in India.

(*Key words: Stethoconus praefectus, Teleonemia scrupulosa, Lantana camara*, biological control, predator)

Teleonemia scrupulosa Stal. (Heteroptera: Tingidae) was imported into India in 1941 for biological control trials against *Lantana camara* L. (Verbenaceae), a serious weed of forests, pastures and waste lands in most parts of the country (KHAN, 1945). Although the insect is known to cause defoliation of the weed in some regions, it was not found capable of suppressing lantana on its own (MUNIAPPAN & VIRAKTAMATH, 1986).

During our studies on *T. scrupulosa*, a mirid bug was found feeding on this insect, which was identified as *Stethoconus praefectus* (Distant) (Heteroptera: Miridae). Laboratory observations revealed that the insect passed through 4 instars. The nymphal stages were whitish in colour and the abdominal tips were upturned. The nymphs were very mobile, often hiding beneath the leaves. The adults were very active and quick fliers. The early instars of the predator were found feeding on the younger stages of *T. scrupulosa*, while the later instars and adult attacked the older nymphs and adults. Feeding was observed to continue for up to 15 minutes depending on size of the predator and prey. Preliminary studies indicated that about 24 bugs of all stages are consumed by an individual for completion of development. *S. praefectus* was found to be active in the field between May and November.

This is the first record of any predator attacking *T. scrupulosa* in India. However, further studies are required to determine the role of *S. praefectus* in preventing *T. scrupulosa* from becoming an effective biological control agent of *L. camara*. *S. praefectus* has been reported to feed earlier on another tingid bug *Stephanitis typica* Distant, which is a pest of coconut in India (MATHEN & KURIAN, 1972). Mass multiplication and field releases of this predator were recommended due to its voracious feeding nature.

The authors are grateful Dr. G. M. STONEDAHL of International Institute of Entomology for identification of the predator and Director, Indian Institute of Horticultural Research for encouragement.

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BRIEF COMMUNICATION

NEW HOST RECORD OF *ARAECERUS FASCICULATUS* (DE GEER) ON ASPARAGUS IN INDIA

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(*Received* 27 *October* 1991)

Adults and grubs of *Araecerus fasciculatus* (De Geer) were recorded feeding on Asparagus. Notes on its nature of damage are reported.

(*Key words: Araecerus fasciculates*, asparagus)

Asparagus, (*Asparagus officinalis* L.) a native of temperate Europe and Western Asia is an important vegetable crop which is becoming popular in India because of its easy cultivation. Asparagus is attacked by many insects like aphids, whiteflies, mites, thrips, mealybugs, asparagus beetles etc. (Hill, 1987).

In Dharwad (Karnataka), asparagus grown in the New Orchard of University of Agricultural Sciences, were found wilted and lodged. Observation of the dead plants revealed the presence of grubs inside the stem. The grubs had caused extensive tunneling inside the stem which was filled with chewed up frass and excreta. The tunneling was confined to the bottom portion (10 to 20 cm from collar region) and the length of tunneling varied from 8 to 20 cm. The damage resulted in distorted growth and yellowing of foliage before wilting and lodging. In each infested plant one or two grubs were seen. These were reared on fresh stem bits in the laboratory and the adults emerged successfully.

The mature grubs were 7 mm long, soft, fleshy, much wrinkled and smoky grey. They pupated inside the stem. The adults were elongate-oval, 5–6 mm in length with a black head and dark brown elytra. Later the insect was identified as *Araecerus fasciculatus* (Anthribidae: Coleoptera) and important store product pest occurring on stored arecanut and coffee seeds. Periodical sampling from October 1988 to April 1989 revealed 23.4 to 55.7 per cent plants being infested. This is the first record of *Araecerus fasciculatus* on asparagus in India.

ACKNOWLEDGEMENT

We are thankful to Dr. M. L. Co, CIE, London, for identifying the specimen.

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Entomon 1994 Vol. 19 No. 3 & 4 pp. 181 to 184

BOOK REVIEWS

DORYLAIMIDA–FREE-LIVING, PREDACEOUS AND PLANT-PARASITIC NEMATODES By M. SHAMIM JAIRAJPURI and WASIM AHMAD, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, Bombay, Calcutta. Price Rs. 495/-, pp. 458.

During the last three decades, a number of publications on dorylaimid nematodes have appeared but there has been no authentic comprehensive review of the whole group and as a result the taxonomy is almost in chaos and beyond the reach of nematologists. Even for specialists, identification of species and genera is very difficult. This is the first attempt in recent years to treat the entire order Dorylaimida in one publication. This book is bound to solve the problems faced by not only beginners but also specialists and will help in identification and placement of various taxa in the hierarchy. The diagnostic characteristics of different taxa and their keys to identification are presented in simple and lucid language. The work is likely to remain a standard reference book for researchers and students engaged in taxonomy of dorylaimide for long time to come.

The book has ten chapters with a preface by the authors and complete with up-to-date references and an index on dorylaimids and triplonchs. The authors have also taken pains to include some of the recent publications under 'Recent additions'.

The first chapter deals with descriptions and illustrations of taxonomic characteristics which will be of great help to beginners and students to fimiliarise with nematode taxonomy. The second chapter deals in detail the diagnotic features of order Dorylaimida and its three suborders and provides key to suborders and super families. This is followed by complete classification of the order Dorylaimida with a list of suborders, superfamilies, families, subfamilies, genera and subgenera. In the subsequent seven chapters each superfamily of the order is dealt with in detail. There is a brief diagnosis of each superfamily, family, subfamily, genera and subgenera and is followed by their respective keys for identification. The type and other species are listed under each genera/subgenera with their synonymies. The type species of each genus/subgenus are also illustrated. The last chapter deals with the order Triplonchida under which two superfamilies viz. Trichodoroidea and Diphtherophoroidea are described in detail. The authors are justified in including the order Triplonchida in this book due to its close relationship with Dorylaimida.

The book is nicely brought out and is without spelling errors. The illustrations are given wherever necessary and are of excellent quality. The type faces used are appropriate and are palatable to the eyes.

The price of the book is also very reasonable. The authors deserve all appreciation for bringing out this book which will be an invaluable reference for students, researchers and specialists in nematology and will be a valuable addition to any library.

C. MOHANDAS

MESOZOIC COLEOPTERA, By L. V. Arnol'di, V.V. Zherikhin, L. M. Nikritin and A. G. Ponomarenko (Editor-in-Chief: B. B. Rhodendorf; Scientific Editor: Natalia J. Vandenberg), Oxonian Press Pvt. Ltd., New Delhi, hard bound, Rs. 395/–, 285 pp (1991).

This book in English is the translation of the book "Mesozoiskie Zhestkokrylye", written in Russian by the four renowned authorities in the former Soviet Union and is based on the excellent collection of the Palaeontological Institute of the Academy of Sciences of the former USSR. The translation of the book into English has been funded under the PL 480 Programme and the original English Edition was published by the Smithsonian Institution Libraries in co-operation with the National Science Foundation (USA).

The book deals with very highly specialised but a major topic, Mesozoic Coleoptera, and appears to be the first review of the evolution of beetles during that crucial era. Though not exhaustive, the book deals with one hundred and eleven species, 64 genera and 19 families of these beetles, most of the species described by the four authors being new and based on well preserved remains, unlike most previous descriptions of the Mesozoic beetles. The descriptions of the species are profusely illustrated. The association of beetles especially with plants and their feeding habits have been discussed in the chapter on composition and ecological characteristics of the group, by Ponomarenko. The book will be of immense value to Palaeontologists and Entomologists, and will be an invaluable addition to the library of especially the former.

V. K. K. Prabhu

TEXT BOOK OF APPLIED ENTOMOLOGY II By K. P. Srivastava, Kalyani Publishers, Ludhiana, New Delhi and Noida (UP), Paper back, 424 pp., 1993, Rs. 80/–

This is the companion volume of *A Text Book of Applied Entomology Vol. I* by the same author published in 1988, and reviewed in *Entomon* Vol. 13, No. 3 & 4 (1988). The book has almost identical get up, but this time mistakes are refreshingly fewer and the author should be complimented for having brought out the book with a lot of information in so few pages. The book is divided into seven sections and twenty-nine chapters, followed by a short bibliography mainly covering a list of books apparently meant for further reading; a very brief subject index and a species index are also included.

The student will find very useful most of the chapters of the book. Among them may be found, for example, methods for collection and preservation of insects. This chapter contains almost everything required by the student under that head, with illustrations of various tools, various media and methods and formulae for preparing them. This chapter is followed by classification which also provides a simple key which the student will find extremely useful. This is accompanied by chapters on insect pests on various crops, their life histories and methods for their control. Pests affecting wheat, maize, millets, paddy sugarcane, pulses, vegetables, fruits, oil seeds, fibre crops, plantation crops and stored grain are provided in detail. Household pests also find their place in the book; locusts and termites have been treated more elaborately; nor are non-insectan pests like rodents and other mammals, birds, snails, mites and nematodes left out. Brief accounts of pests of farm animals and those

of public health importance and arthropod borne diseases of man have also been provided. Venomous arthropods, including symptoms and treatments for arthropod venoms have also been briefly described. Mulberry and non-mulberry sericulture, apiculture as well as lac culture are dealt with in detail. One also finds accounts of insects attacking forest trees and a chapter on forensic entomology in the book.

In short, the author has made sincere effort to compress maximum information into the book and yet has used illustrations profusely which serve the purpose of conveying the ideas better and briefer than words, as for example, the diagrams used to illustrate the insects' life history. The illustrations have invariably explanations of the figures accompanying them beneath, which makes the book easy to follow. The book is written in lucid, clear and simple style, and the language used is easily comprehensible. The emphasis throughout is on Indian examples. In short, students of Applied Entomology of most Indian Universities will find this easily affordable book a boon; it will also be of considerable help to teachers and many researchers in Entomology. The book can be recommended for most Zoology/Entomology Libraries.

V. K. K. Prabhu

BIOECOLOGY AND CONTROL OF INSECT PESTS, Edited by S. C. Goel and Published by Uttar Pradesh Zoological Society, Muzaffarnagar; hardbound, 279 pp., Rs. 300/- ($ 60/- abroad) Postfree.

Bioecology and Control of Insect Pests is the Proceedings of the fourth of a series of symposia on Insect and Environment: Growth, Development & Control Technology of Insect Pests, held at P. G. Department of Zoology, Sanatan Dharm College, Muzaffarnagar, during 2-4 October 1991. It comprises forty-five papers presented at the symposium by scientists from different parts of India and represents a cross section of the work that is going on in various entomological laboratories in this field in India. The *Proceedings* has been broadly divided into two sections: Bioecology of insect pests and control of Insect pests. It deals with insects which are pests of crops or their products and of public health importance; their parasites, parasitoids and predators are of course included; so are some useful insects like silkworms, though not considered pests. Evidently, the editor has done a good job in compiling and editing the various papers presented at the symposium covering heterogeneous aspects of Insects' life and man's attempt to control them using a variety of techniques. The book will be an asset to entomology libraries and research workers in the field.

V. K. K. Prabhu

CURRENT INDIAN FORESTRY, ENVIRONMENT AND WILDLIFE ABSTRACTS, Sudhir K. Arora (Managing Editor); Published by Agrim Publishers (Anekant Place, 29 Rajpur Road, Dehra Dun), Rs. 275/- (India), $ 58 (abroad, air mail), $ 35/- (abroad, surface mail), per volume.

Current Indian Forestry, Environment & Wildlife Abstracts (CIFEWA) is a new quarterly journal abstracting Indian research articles in the disciplines indicated by the title. Currently the journal abstracts articles appearing in 35 Indian journals and also proposes to include abstracts of papers presented at the symposia, workshops and seminars in these fields. The

journal is published quarterly, four issues per volume, in July, October, January and March, in a financial year. 1st issue (Vol. 1, No. 1) comprising 98 pages, 270 abstracts, was published in July 1993 and annual target is to have 1200 abstracts per volume. In addition, various indexes are also given which are useful to locate abstracts in the issue. The journal will be of considerable help to research workers in Forestry, Environment, Wildlife and other related fields and is recommended for libraries in the above disciplines.

V. K. K. PRABHU

OBITUARY

PROF. T. SANTHANARAMAN
(1916–1993)

We deeply regret to report the demise of PROF. T. SANTHANARAMAN, former Government Entomologist, Agricultural College and Research Institute, Coimbatore after a brief illness on 20th April 1993 at Madras.

Prof. Santhanaraman was born on 5th March 1916 and graduated from the Agricultural College at Coimbatore in 1943. He served the Department of Agriculture in various capacities. He started his career as Assistant in Entomology in 1943 and was promoted as Lecturer in Entomology in April 1957. He became the Government Entomologist in June 1965 in which position he served till his retirement. His contributions in the field of crop entomology deserves special mention. He was a Fellow of the Entomological Society of India.

B. V. DAVID

ADDENDUM

To the Paper:

"TWO NEW SPECIES OF FIG WASPS (HYMENOPTERA: AGAONIDAE) FROM KERALA, INDIA", *Entomon*, **19** (1 & 2), 29–33, 1994, by D. R. PRIYADARSANAN & U. C. ABDURAHIMAN, Department of Zoology, University of Calicut, Kerala, India-673 635 (*Received* 14 *November*, 1994).

In the wake of the recent revision of Indo-Australian Agaonidae by Wiebes (1994), we would like to make the following generic changes in our identification of the two new fig insects. Accordingly, relevent modifications for the 'remarks' are also made.

1. *Eupristina* (*Parapristina*) *keralensis* (Priyadarsanan & Abdurahiman) *Waterstoniiella keralensis* Priyadarsanan & Abdurahiman, *Entomon*, 1994.

Remarks: The subgenus *Parapristina* is so far known only from the figs of section Leucogyne Corner and subsection Benjamina (Miq) Corner (Wiebes, 1994). Now this is new report of a *Parapristina* sp. from the figs of subsection Dictyoneuron Corner of section Conosycea.

Eupristina (*Parapristina*) *keralensis* resembles *Eupristina* (*P*) *verticillata* Waterston (1921). However, the new species differs in the following characters: For the female the 6th antennal segment is broader than the 7th (while in *E. verticillata* the 7th is the largest antennal segment). The mandible has only one gland and 3 lamellae (*E. verticillata* has two and five respectively). In the case of the male, the antenna is five segmented (it is 4 segmented in *E. verticillata*). The foreleg tarsus bimerous, midleg tarsus and hindleg tarsus pentamerous in *Eupristina* (*P*) *keralensis*, while in *E. verticillata* it is trimerous in foreleg and tetramerous in mid and hind legs.

2. *Dolichoris beddomeiae* (Priyadarsanan & Abdurahiman)

Platyscapa beddomei Priyadarsanan & Abdurahiman, Entomon, 1994. *Additional description:* Mesosternal pollen pockets absent. Foreleg coxe without comb and corbiculae.

Remarks: This species is more related to *Dolichoris inornata* Wiebes (1978). The female has two dorso-apical teeth in *D. beddomei*, while *D. inornata* has three dorso-apical teeth in their foreleg tibia. The male antenna has three annular segments and foretarsus is pentamerous, while in *D. inornata* there is only one annular segment in the antenna and foreleg tarsus is bimerous.

It should be noted that the *Ficus* spp. of the series Validae Miq. (which includes *F. beddomei*) of the section Conosycea are generally pollinated by the species of *Dielagaon* Wiebes. Likewise, insects of the genus *Dolichoris* Hill are reported only from *Ficus* of section Oreosycea (Miq.) Corner. So this an aberrant record both for the insects genus and for the *Ficus* section.

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ANNOUNCEMENTS

FRASERIA

FRASERIA, the South Asian Bulletin of Odontology - the new, rejuvenated and combined newsletter and bulletin of short research communications intended to be a semi-annual South Asian bulletin of Odontology, has started publication with the release of Volume I, Number I (June 1994). Subscription Rs. 120/- (India); US $20/- (abroad) for two issues constituting one volume. Supplied *gratis* to SIO members. Details may be had from Dr. D. B. Tembhare, Chief Editor, *FRASERIA,* Department of Zoology, Nagpur University Campus, Nagpur 440010, India.

TORYMIDAE AND EURYTOMIDAE OF INDIAN SUBCONTINENT (HYMENOPTERA: CHALCIDOIDEA), a Monograph on the Indian species of Torymidae and Eurytomidae by Professor T. C. NARENDRAN, Department of Zoology, University of Calicut, 500 pp. (Published in January 1994).

This monograph provides well illustrated latest revision of the species and genera of Torymidae and Eurytomidae of Indian subcontinent. Fifty-eight genera and 287 species are dealt with taxonomically with brief surveys on their biology, morphology and distribution. Simple and illustrated dichotomous keys to genera and species are provided along with detailed diagnosis of each taxon. It also includes several new synonyms and several new combinations. A host parasite catalogue is also given.

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